Dear Colleagues,

The XXXV World Congress of Audiology will be held in Warsaw, Poland, on 10–13 April 2022. We are thrilled to invite you to come to Warsaw to join the gathering of scientists and practicing audiologists coming from all over the world to share their latest clinical and research achievements. We trust that it will be a productive and stimulating meeting for all participants.

We invite delegates from all continents to book the date and attend the XXXV WCA 2022 in Warsaw, Poland.

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Keynote Lectures

Audiological battery test in tinnitus patients

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In most cases, tinnitus is subjective, being defined as the patient's only perception of involuntary sounds, which do not have a real correspondent in the surrounding sound environment and are perceived in one of the ears or in the head. The impact of these sounds on the patient varies widely, from ignorance to despair and even suicide attempt. The management of the patient with tinnitus involves a detailed history, completed by self-assessment questionnaires of the impact of the tinnitus, subjective and objective audiological tests, imagistic or neurological investigations. If the etiology of tinnitus can be identified, the causal treatment for 1–3 months is the first intention treatment. In the absence of any benefit, drug therapy, cognitive therapy (TRT – Tinnitus Retraining Therapy), prosthetic or psychological treatment may be recommended.

Audiological results of middle ear surgery

Stankovic M.

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Pathological processes affecting middle ear are diverse: congenital, inflammation, otosclerosis, tympanosclerosis, etc. Thus their effect on hearing is unequal. Surgical rehabilitation of conductive hearing loss is well established, techniques and new material are developed. However, the audiological results are mainly presented as case series, so evidence based date are still surprisingly insufficient. We present our audiological results with surgical treatment of congenital malformations of external and middle ear, ossiculoplasty, surgery for cholesteatoma, otosclerosis and tympanosclerosis. Evidence based data are discussed for each of the potentially influential factors for the success of these operations. For malformations particular data are presented for long-term hearing outcome of canaloplasty with partial ossicular replacement in congenital aural atresia, and comparing audiological outcomes between the bonebridge and bone conduction hearing aid on a hard test band, as well as for evaluation of four outcomes measures in microtia treatment: exposures, infections, aesthetics, and psychosocial ramifications. For analysis of ossiculoplasty the following data are compared: partial and total titanium prostheses in children, titanium versus non-titanium prostheses in ossiculoplasty, the use of bone cement in ossicular chain reconstruction and revision stapes surgery.

Auditory Brainstem Implant in children: Looking back and moving forward

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Introduction: Auditory Brainstem Implant (ABI) is an emerging option for children with cochlear/nerve aplacia. Unlike cochlear implants the outcomes with ABI are unpredictable; however the outcomes are variable among the cohort. Long-term outcomes with ABI are scarcely published; this study had profiled the outcomes in children with ABI. **Objective:** The primary objective is to measure the subjective outcomes at different intervals to monitor the trend in the development of communication skills. Secondary objective is to correlate the long-term outcome with Electrically Evoked Auditory Brainstem Response (eABR), third objective is to predict the nature of electrode based on the morphology of eABR and the fourth objective is to explore the relationship with CN eCAP with other measures. **Methods:** 50 children with ABI were studied retrospectively with mean implant age of 3 years 8 months. The subjective outcomes were measured at five intervals using CAP, SIR, MAIS, MUSS and LEAQ. The measures include pre-activation and post activation at 12 months, 24 months, 36 months and 48 months. eABR was measured post-operatively in all the subjects. Using behavioral methods, sensation elicited by each electrodes were measured. CN eCAP was measured in 20 subjects with ABI using a novel ART methods. **Results:** Scores improved gradually till 24 months post switch-on, after 24 months a plateau in scores were observed. By 48 months, a maximum of 6 participants showed a median score of 5 in CAP and a total of 10 participants revealed a median score of 4 in SIR. LEAQ scores showed 4 children with ABI were comparable to children with cochlear implants. Outcomes were better in children, where more than 75% of electrodes elicited good eABR. A positive correlation was found between the subjective scores and number of electrodes with good eABR. Morphology of eABR were variable across electrodes and subjects, peaks vary from 1 to 4, first three peaks were early, less than 4.5 ms. Peaks with late latency >5.5ms were higher in amplitude compared to early peaks. Some experienced subjects were able to give consistent response behaviorally differentiating auditory and non-auditory sensation for each electrode stimulated. CN eCAP could be measured in few electrodes across subjects, since it is very preliminary data the morphology and its relationship will be discussed during presentation. **Conclusions:** Outcomes with ABI in children are variable, however speech production is very poor compared to auditory comprehension. Though the outcomes are not comparable to CI users, few children auditory performance are comparable to CI users over a period of time. eABR is a reliable tool, and a good predictor of outcomes. Absolute latency and morphology of eABR was will differentiated between auditory and

non-auditory electrodes, morphology of eABR is a good predictor of the nature of the electrode which was very useful during programming the boundaries of stimulation in very young children. Children with ABI require a longer period of rehabilitation and some children need to be dependent on visual cues for communication. However all children with ABI use the device consistently and dependent on the same for some cues which are yet to be explored.

Difficulties and diagnostic challenges in detecting hearing loss in adolescents

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Objectives: Hearing deficiencies are more prevalent nowadays. They diminish the quality of life of patients and impair their abilities to effectively communicate in the society. What is the most threatening is the fact that disorders of the auditory system tend to more frequently occur at earlier age of the life of the individual**. Material:** A group of adolescents (all under the age of 18), who came to the Audio-vestibular and Sleep laboratory at the University medical and dental center, Medical University – Varna, is studied. Patients presented with symptoms from the auditory system – diminished hearing capabilities, symptoms of tinnitus, pain in the ear and pharyngeal area, some of them with intermittent fever. All were screened for recent or more distant medications intake and recovering from viral or bacterial diseases, including COVID-19. All patients filled out questionnaire forms and signed written informed consent forms. **Methods:** All individuals, included in the following study, underwent audiometry, tympanometry, OAE, SERA examinations, VNG, vHIT, as well as a full dental check-up and examination of the temporomandibular joints. Where necessary, imaging diagnostic was implemented – X-Ray or CBCT-scan of the oronasal cavities and TMJ-area. **Results:** Diminished hearing capabilities were diagnosed in the presented group of patients. Tinnitus tends to manifest more frequently at younger age. Due to hearing screening campaigns organized hearing loss is found in a timely manner. No pathologic symptoms from the vestibular system were detected. **Conclusions:** Immediate and adequate measures must be undertaken when a hearing disorder is under doubt. The target should be – providing the adolescent patient with a diagnostic and treatment plan that will assess his or her condition, try to and cure it and maintain the quality of life.

Electrocochleography in CI subjects

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It is desirable to use intraoperative monitoring during the electrode insertion to preserve residual hearing during cochlear implant (CI) surgery. A promising method is Electrocochleography (ECochG). The aim of the monitoring is to identify critical steps during insertion as well as to modify the ongoing insertion procedure immediately, if necessary. Also for postoperative follow-up of the patients ECochG opens new possibilities, especially in the objective estimation of residual hearing. ECochG can be recorded at different sites. For extracochlear recordings usually a cotton wick electrode at the promontory wall is used together with a clinical EP device. For intracochlear recordings the CI electrode can be used, either together with a clinical EP device or by using the telemetric system of the CI manufacturer through the implant. Telemetric systems can also be used postoperatively during the follow up as no extra electrode is needed. In this talk different recording sites and strategies are discussed. Intraoperative data of 100 extracochlear and 50 intracochlear recordings with different CI manufacturers are available as well as some long-term data during the follow up. Altogether, ECochG can be recorded intra- and postoperatively very well. First analyses indicate that in case of a deterioration of the recorded extracochlear signal a certain trauma is likely. Especially, with intracochlear recordings promising relations to the audiometric pure tone threshold could be detected when measured at the same appointment.

Factors affecting the results of cochlear implantation. Evidence based data

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Cochlear implant (CI) is an electronic substitute for lost mechanosensory hair cells that successfully provides hearing to people with severe to profound hearing loss. Technical progress has implemented some new indications for implantation such as: children under 1 year of age, CI and hearing preservation, unilateral deafness, unilateral deafness and tinnitus, genetic hearing loss, bilateral implantation, auditory neuropathy, and neural plasticity. However, CI is not a passive sensory aid or sensory substitution device that replaces a damaged cochlea. All patients with CI must have an extended period of aural rehabilitation: perceptual learning, adaptation and readjustment of their attentional networks, brain and central nervous system substantial reorganization and realignment to adapt to the highly-degraded, compromised, incomplete and sparsely-coded novel electrical input signal by the CI. Patients with cochlear implants may suffer from difficulties in processing complex sounds (music), and discriminating sounds in noisy environments. Problems in AR are individual differences and variability in outcomes and preimplant predictors of outcomes after implantation, so developing novel interventions for poor outcomes is a further task. General factors for the success of CI are numerous and can be summarized as: hearing preservation, electrode diameter & position, residual hearing, CI under 12 months, bilateral CI, multisensory integration. Specific factors are: inner ear malformations enlarged vestibular aqueduct, genetic etiology, additional disabilities, VIII n. aplasia & hypoplasia, auditory neuropathy, cognitive skills, single sided deafness, and tinnitus. Current references concerning each of mentioned potential factors of the success are presented. Future development in surgical rehabilitation of advanced sensorineural hearing loss is also presented.

Gaps in Noise Test: Findings in neurologically based central auditory disorders

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The Gaps in Noise (GIN) Test was introduced in 2005 as a new procedure for the evaluation of central auditory disorders.

Since that time it has become a popular test used world-wide for the evaluation of those with suspected central auditory dysfunction. This presentation will reveal the results from a Meta-analysis looking at the diagnostic value of the GIN test focusing on neurologically based lesions of the central auditory nervous system. Included in the analysis will be sensitivity, specificity and efficiency of the GIN procedure. Also addressed will be positive and negative posterior probabilities, Forest plots, positive and negative likelihood ratios, and diagnostic odds ratios. This will follow introductory comments on procedural and neuro-biologic background of the GIN test. This session will conclude with a presentation of interesting case study analysis.

Hyperacusis: Pathophysiology and clinical management

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Hyperacusis is a serious health problem affecting a substantial proportion of children and adults seeking care from audiologists. Hyperacusis is characterized by reduced loudness discomfort levels ("loudness hyperacusis"), but reduced LDLs do not always capture the full complexity and severity of symptoms, which can include weeks of ear pain after even a brief exposure to loud sound ("pain hyperacusis"). Following a review of our current understanding of the physiological mechanisms underlying loudness and pain hyperacusis, this session describes a clinically feasible approach for accurate diagnosis and effective intervention of an underserved patient population. Hyperacusis often co-occurs with difficulties hearing speech in noise, audiometric threshold shifts, and the phantom sensation of tinnitus. Animal models and several human brain imaging studies suggest that hyperacusis results from hyperactive and/or hyper-synchronized neurons in the auditory brainstem and cortex, and that this hyperactivity may be a compensatory response to peripheral hearing loss, mediated by depressed synaptic inhibition and/or potentiated excitation. Although some patients complaining of hyperacusis have "clinically normal" hearing sensitivity, the audiogram can fail to detect outer hair cell losses of up to 30–40%, and inner hair cell or auditory nerve fiber (ANF) losses of up to 60–80%. Thus, a clinically normal audiogram does not preclude the possibility of substantial damage to the cochlea. Nevertheless, hyperacusis can also arise from central neural hyperactivity in the absence of any peripheral hearing loss, as in autism and migraine for example. Recent research suggests that type-II ANFs may signal pain associated with loud sound, and it could be that the threshold for such pain sensations is lowered in some patients with hyperacusis. In common with many neurologic disorders, hyperacusis is exacerbated by stress, anxiety, isolation, and insomnia (especially when comorbid with tinnitus), among other factors. The development of an effective management plan for hyperacusis is based on findings from detailed patient history and comprehensive audiological assessment. The patient history must include questions about diseases and disorders that may include hyperacusis as a symptom, such as William's syndrome, migraine, and depression. In addition to conventional pure tone audiometry and LDLs, important components of a diagnostic test battery for the assessment of hyperacusis patients are completion of an inventory to assess the impact of hyperacusis on quality of life and daily activities plus the measurement of high frequency hearing sensitivity (>8000 Hz), distortion product otoacoustic emissions, and speech perception in noise. Management options, based on the patient's history and outcome of diagnostic assessment, include extensive counseling, a program for desensitizing responses to bothersome sounds, sound therapy, formal programs such as tinnitus retraining therapy, and prompt patient referral to appropriate medical specialists.

Longitudinal linguistic and auditory outcomes in children with single sided deafness and a cochlear implant

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Each year, approximately 20 children are born in Flanders (Belgium) with single-sided deafness (SSD), i.e. profound hearing loss in one ear (>90 dB HL) and normal hearing in the other ear. These children not only experience difficulties with localizing sounds and understanding speech in noisy environments, but may also be at risk for speech-language delays. Despite these findings, there is currently no standard care for these children in Belgium (as is the case for many other countries worldwide). A cochlear implant (CI) in the deaf ear offers the potential to restore binaural hearing. Early implantation is likely of key importance, given the sensitive period for brain development early in life. In our current multicenter study (Leuven, Antwerp and Ghent), fifteen infants with congenital SSD received a CI at a very young age (range 8–26 months, mean 13.6±4.8 months). At regular intervals we document the development of these children in terms of receptive and expressive language skills, cognitive abilities, and (from the age of four) localization and speech perception skills. Additional measures include parent questionnaires addressing their auditory, language, and socio-emotional development. I will present ongoing language and auditory data of the implanted children age 2 and older. Data will be compared to those of both matched normal hearing peers and matched single-sided deaf children without a cochlear implant.

Molecular biomarkers of neuroplasticity in prelingual deafness treatment with CI – is serum activity of MMP9 and its functional polymorphism a one?

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Introduction: Treatment of congenital deafness with neural prostheses allows for effective acquisition of language skills, however considerable interindividual differences among

implantees exist. To date very little or nothing is known about determinants of linguistic proficiency development, other than age of implantation, in children without comorbidities. Genetic biomarker of neuroplasticity in prelingualy deaf children treated with cochlear implantation could facilitate their clinical management, especially rehabilitation, giving higher chances for development of robust proficiency of spoken language. In the study we investigated whether carrying of a certain variants of genes encoding matrix metaloproteinase MMP-9 and BDNF and serum level of MMP9 at CI activation is a prognostic marker of auditory skills acquisition outcome. **Method:** We performed a prospective analysis of serum activities of MMP9 at activation, 1, 5, 8, 18 months follow up in the group of 50 children, diagnosed with bilateral profound sensory- neural hearing loss genetically based by 35delG GJB2 mutation, aged below 2, treated with unilateral cochlear implantation. Also the analysis of functional variants of MMP9 (RS 3918242, -1562 C/T, known to affect MMP-9 gene expression levels) and rs6265 of BDNF (Val/Met, known to affect the protein function) was performed. We studied associations between serum activities of MMP9 in the aforementioned intervals and trajectory of auditory development of the implanted children and also associations between carrying of relevant variants of MMP9 and BDNF and auditory development of implanted children. Language acquisition was assessed with Little Ears Questionnaire. **Results:** Statistical analysis shows that carriers of C/C of rs 3918242 of MMP9 score in LEAQ at 18 months follow up statistically significantly higher than carriers of C/T. We haven't found any statistically significant relation for variants of rs6265 of BDNF. Correlation analysis shows that there is a significant negative corelation between level of serum activity of MMP9 pre-implant and LEAQ score in 18 month follow up (rho=–0.40, p=0.07). **Conclusions:** C/C of rs 3918242 of MMP9 predisposes their deaf carriers to better response to a sensory stimulation up to 18 months post CI activation than carriers of the other variant of rs 3918242 MMP9. Low serum level of MMP9 activity at CI activation predisposes deaf children to better response to a sensory stimulation delivery to cochlea during first 18 months after CI activation. Further studies should address potential biomarker value of those genetic variants as well as possible functional role of MMP9 and BDNF in neuroplasticity evoked by cochlear implantation in the prelingually deaf children.

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Ototoxicity induced by exposure to organic solvents and noise

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Exposure to chemicals in the workplace can lead to hearing loss, as many chemicals have been internationally recognised as hazardous to hearing. Several studies have demonstrated that organic solvents such as toluene, styrene and xylene induce ototoxicity. Specifically, animal studies have shown that organic solvents adversely affect the outer hair cells and when experimental animals are co-exposed to organic solvents and noise, a synergistic effect is observed. In addition, animal studies have also demonstrated that organic solvents can affect the central auditory pathways in the brainstem. Human studies have systematically documented that workers exposed to organic solvents present with a higher prevalence of hearing loss than workers without solvent exposure. Also, human studies have found that solvent exposure is associated with central auditory dysfunction. Therefore, workers exposed to organic solvents should be incorporated in hearing conservation programmes, even if they are exposed to noise levels within the recommended limits. In this presentation, a summary of the current evidence about the ototoxicty of organic solvents with and without co-exposure to noise will be discussed. In addition, the mechanisms of ototoxicity induced by organic solvents and the strategies for early detection and prevention will be addressed.

Presbycusis

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Age related hearing loss (presbycusis) is one of the most common sensory deficits in the aging population. The typical signs of presbycusis comprise increasing hearing thresholds at high frequencies and the deterioration of hearing in a noisy environment, which in humans hinders speech comprehension. In this study I will review the major changes in the auditory system occurring during aging, reporting on data obtained both in experimental animals and human subjects. A typical feature of aging in the inner ear represents deterioration of the function of the inner and outer hair cells, that culminates in their loss due to apoptosis. Lifetime noise exposure results in deterioration of the function of synapses between the inner hair cells and auditory nerve fibers, called auditory synaptopathy or hidden hearing loss. Another inner ear structure that deteriorates with aging is *stria vascularis*, leading to a metabolic type of presbycusis. Experiments on animals show that significant age-related changes also occur in the central auditory pathway. This deterioration particularly concerns the inhibitory transmission, as demonstrated by means of an immunocytochemical detection of decreased levels of glutamate decarboxylase. Similar age-related decreases appear in the central auditory system in the levels of calcium-binding proteins, such as calbindin, calretinin and parvalbumin. In addition, an age-related loss of the temporal function of neurons has been demonstrated in animal experiments. When stimulated with wide-band sounds, such as noise or clicks, the aged auditory system of experimental animals exhibits a decline in the precision and reliability of both the rate code and the temporal code. Presbycusis represents a combination of pathologies occurring in the inner ear, as well as in the central auditory system. Nowadays, manifold methods are available to characterize age-related deterioration of the auditory function. Classical methods of subjective audiometry may be complemented by the recording of otoacoustic emissions and examination of the complex auditory function, with methods originally developed for studies in psychoacoustics. Results show that in addition to typical age-related increases in high-frequency hearing thresholds, the subjects display a deteriorated processing of temporal

parameters of sound (with changes in gap detection threshold and interaural time difference detection). Several of these findings are supported by measurement of the auditory function, with objective electrophysiological methods such as auditory brainstem responses, frequency-following responses or middle-latency responses. New insights into the mechanisms of presbycusis, especially with regards to the pathological states of the central auditory system, offer several methods of magnetic resonance imaging. MR spectroscopy shows that aging is connected with lower concentrations of glutamate, GABA and N-acetylaspartate in the auditory cortices of elderly subjects. MRI morphometry studies demonstrate that the gray matter thickness in the Heschl's gyrus, planum temporale and gyrus frontalis superior, decreases with aging. However, aging did not influence the laterality of these structures, i.e. dominance of the left side. Concerning the white matter, a recent study with fixel-based morphometry shows that aging is connected with a reduction of fibers in the pathways connecting the structures of the central auditory system, but the connections of these structures with limbic structures, such as amygdala or hippocampus, are even more reduced. Acoustically evoked activity recorded by BOLD fMRI from an area centered on Heschl's gyrus, is more pronounced in the elderly subjects than in young subjects. In addition, the activation by acoustical stimuli is more expressed in the right temporal lobe than in the left temporal lobe in the elderly. These results suggest that aging not only has negative effects on the structure and function of the inner ear, but also on the central auditory system.

Robot-based ear surgery: Does it improve audiological outcomes?

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Robot-assistance to ear surgery has been developed during the last 2 decades to increase the surgical accuracy in different ear domains such as cochlear implantation and endoscopic ear surgery, for either otosclerosis or chronic ear sequelae. Although most of the studies were performed on temporal bone preparations, only few devices can be used in operating rooms at present. RobOtol® (Collin, Bagneux, France) is a robotic arm tele-operated by the surgeon through a SpaceMouse® designed and prototyped in our research laboratory, which has been commercially available for 4 years (EC certificate in 2016). For cochlear implantation, all kinds of electrode arrays of the different brends (Advanced Bionics, Cochlear, Medel, Nurotron, Oticon) can be adapted to the robotic arm. RobOtol® allows a slow and constant insertion speed of the electrode array into the cochlea. It also offers the possibility to modify the insertion axis following the optimal axis of insertion within the basal turn of the scala tympani. According to the robotic-assistance procedure, the rate of translocations from scala tympani towards the scala vestibuli was dramatically reduced depending on the electrode array type, either in adults and infants, and hearing preservation could be achieved in most of the attempted cases. After 1-year of cochlear implant daily use, the restoration of high-frequency thresholds was correlated to better speech perception in silence, although the number of translocated electrode arrays was reduced using a robot-based insertion. For EES, it was demonstrated that all kinds of ear surgery, including eardrum graft, ossicular replacement, and otosclerosis could be performed using an endoscope connected to RobOtol® which allowed to operate on with 2 hands. This procedure can be extended to deeper region of the petrous bone. Besides demonstration of technical safety and feasibility anatomical and functional outcomes were similar those achieved under classical microscopic procedures.

The Esteem active middle ear implant

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The Esteem (Envoymedical, St. Paul, USA) is at the present the only FDA-approved fully-implantable middle ear device. Indications include all sensorineural hearing loss degree up to the severe-to-profound types. Our Implanting Center has achieved the experience with 46 cases from 2007 up to now. This long-term follow-up allowed us to make some considerations regarding surgery-related issues, functional outcome over the time and battery-related issues. Surgery is complex mostly due to the use of tools that are not part of the routine ear surgery (screws, cement) and despite the learning curve still has a rather long duration (around 3 1/2–4 hours). The functional gain at activation was excellent in over 80% of the cases, with a few requiring a revision to be optimized. The hearing improvement was satisfactory for any form of sensorineural hearing loss, including the severe-to-profound forms. During the long follow-up ranging from 4 to 14 years, it was possible to observe deterioration of the bone conduction threshold in the operated ear that was also noticed, but to a lesser degree, in the contralateral ear. The majority of these subjects could still benefit from a good functional outcome, while only in few of them a transition to a cochlear implant was needed. It is possible to conclude that the Esteem represents in selected subjects an optimal rehabilitative solution in alternative to conventional hearing aids that should always been proposed as the primary aid for subject with sensorineural hearing loss.

The impact of binaural hearing on complex language learning and verbal cognition

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Objectives: More and more deaf children are wearing two devices: a cochlear implant + hearing aid or two cochlear implants. The objective of this study was to assess the role of bilateral/bimodal device use on auditory speech perception in complex listening situations and long-term verbal cognition in deaf children using cochlear implants (CI). **Material:** Two groups of deaf children with cochlear implants were compared (16 unilateral and 21 bilateral device users) on vocabulary, on speech perception at conversational level, in complex listening situations and on verbal cognition. **Method:** It was

a retrospective study on longitudinal data of deaf children with unilateral or bilateral devices: 37 children with normal learning potential of which 16 were unilateral device users and 21 were bilateral device users (9 with a bimodal fitting and 12 with bilateral CIs). **Results:** The main outcome measures were the verbal cognition at 60 months. Further measures were open-set speech perception at 45 and 60 dB SPL, speech perception in noise, and receptive and expressive vocabulary. All measurements were made at 36 months post-implantation. The important factor associated with verbal cognition was the presence of binaural hearing (bimodal or bilateral). Bilateral input enhances complex listening skills and enables development of verbal cognition skills by learning in implicit, incidental (learning) situations. **Conclusions:** Deaf children who use bilateral devices have the opportunity to develop good speech perception skills in complex listening conditions. These abilities enable at least part of the children to develop age-equivalent verbal-cognition skills.

The impact of tinnitus on sleep and how this can be managed with audiologist-delivered Cognitive Behavioural Therapy?

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Background and objectives: Tinnitus is the perception of sound without any sound source. Approximately, 70% of patients seeking help for tinnitus present with symptoms of insomnia. It is not clear whether the degree of insomnia is directly related to the loudness of tinnitus or to its psychological impact on the sufferer. If the latter, then the application of cognitive behavioural therapy (CBT), which aims to address the psychosocial impact of tinnitus, should improve tinnitus-related sleep disturbances. This study had two phases. The first phase aimed to assess the relationship between the loudness of tinnitus and sleep disturbances using a mediation analysis. The second phase aimed to (1) evaluate the improvements in quality of sleep after audiologist-delivered CBT, and (2) to assess the perspectives of patients about different aspects of CBT. **Material:** Assessment procedures: Audiological measures were the Audiometry and Uncomfortable Loudness Levels. Questionnaires administered comprised: Visual Analogue Scale (VAS) for tinnitus loudness, and tinnitus annoyance, Tinnitus Handicap Inventory (THI), Insomnia Severity Index (ISI), Generalized Anxiety Disorder (GAD-7), and Patient Health Questionnaire (PHQ-9). Treatment procedures: Audiologist-delivered CBT is broadly similar to CBT delivered by psychologists and includes: (1) Empathic listening informed by the client-centred counselling method; (2) Developing a case formulation that provides an explanation of the mechanism by which tinnitus leads to distress, based on cognitive theory; (3) Application of behavioural experiments to explore and modify negative thoughts and safety seeking behaviours; (4) Keeping of a Diary of Thoughts and Feelings to provide a structured method for the patient to take notes about their tinnitus problems, and their associated thoughts and emotions. **Method:** This was a two-phase retrospective cross-sectional study. In phase one, the data for 417 consecutive patients seeking treatment for tinnitus in an Audiology Department in the UK were analysed. To explore the mechanisms underlying the relationship between tinnitus loudness and ISI score, variables that significantly predicted insomnia in the stepwise multiple-regression model were included in a mediation analysis. In phase two, the data for 40 consecutive adult patients who received a full course of audiologist-delivered CBT for tinnitus management were included. As a part of their routine care, all patients completed a wide range of questionnaires before and after receiving audiologist-delivered CBT. Pre and post treatment scores on ISI were compared in order to calculate its effect size. **Results:** Phase 1: Mediation analysis showed that the relationship between tinnitus loudness and insomnia was fully mediated via depression b 0.53 (95% confidence interval, CI: 0.35 to 0.71), tinnitus handicap b=0.38 (95% CI: 0.16 to 0.6), and tinnitus annoyance b=0.33 (95% CI: -0.004 to 0.66). Phase 2: The majority of patients reported that it was very acceptable to them to receive CBT focused on tinnitus from a specialist audiologist. The majority of patients felt that the CBT was very effective and that they were able to manage their tinnitus well. The effect size of treatment based on pre- and post-intervention comparison of scores for the ISI was 0.92 (95% CI: 0.38 to 1.5). **Conclusions:** Insomnia is not directly related to tinnitus loudness. Depression, tinnitus handicap and tinnitus annoyance mediate the relationship between tinnitus loudness and insomnia. Audiologist-delivered CBT is acceptable to patients and is effective in the management of tinnitus-related insomnia symptoms from the patients' perspectives.

The International Journal of Audiology in the new landscape of science publishing

Morata T., Clark J.

International Journal of Audiology, International Society of Audiology, Switzerland

The role of science literacy in shaping behavior and attitudes for individuals, communities and society is being hotly debated in recent years. The debate includes the scientific publishing landscape, which is undergoing dramatic changes. Scientists have access to new opportunities, information and metrics but also have to face new challenges and pressure when making decisions of where and how to disseminate their work. A focus on open access by funders and institutions has promoted greater sharing of research results. Complexities regarding peer review, reproducible research, data management, the growth of predatory journals, and an increase in retractions also add to the call for more transparency and openness. This presentation will address these issues to help researchers navigate the scholarly publishing process and give an update on the approaches the "International Journal of Audiology" is taking to stay competitive and generating new science.

The sound of a cochlear implant: Studies with single sided deaf listeners

Dorman M.

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In the past decade, single-sided deaf listeners have received cochlear implants (CIs) for the relief of tinnitus, to improve speech understanding in noise and, most generally, to improve

overall quality of life. The data indicate that CIs have been successful in all of these domains. In this talk, I describe a new direction for research with this patient population, i.e., to determine the sound quality, or voice, of a cochlear implant. The presence of a normal hearing ear and an ear with a CI in the same individual allows us to conduct a simple experiment. A clean signal is first directed to the CI ear, and then to the normal hearing ear. The patient is asked how the signal to the normal hearing ear needs to be changed so that it sounds like the signal in the CI ear. Working interactively with the patient, we modify signal parameters such as voice pitch, frequency spectrum, intonation contour, metallic sound quality (as well as a host of other parameters) in an effort to match the sound quality of the CI. At the end of the interactive session, patients are asked how similar, on a scale of 1-10 (with 10 being a complete match), the signal to the normal hearing ear is to the sound of the CI. We have been able to achieve match scores of greater than 9 out of 10 indicating that, for many patients, we can come very close to the sound of their CI. Our first results showed that CIs do not sound like either noise or sine vocoders. This was important as the 'simulations of a CI' found on the internet always use a vocoder. Our current results document that CI sound quality depends on the frequencies in the spiral ganglion that are stimulated by the most apical electrodes in the CI array. If the frequencies are relatively near the input frequencies in the signal (and there is some flexibility), then we find no, or very little, upshift in voice pitch or formant frequencies. In this case, the dominant perceptual difference between a clean signal and the CI signal is that the CI signal sounds 'muffled' to one degree or another or has a slightly flattened intonation contour. In contrast, when there is a larger distance between the place of stimulation in the spiral ganglion and the frequencies in the input signal, patients match to signals that are upshifted in pitch or in formant frequencies. These voices sound like the little people actors, or 'Munchkins', in the 1939 American classic movie, "The Wizard of Oz". Most recently, we have explored the sound of combined acoustic and electric stimulation in the same ear. Surgeons are now able to preserve residual low-frequency hearing in the implanted ear of a single-sided deaf patient. We are able to obtain matches to (i) the sound of low-frequency acoustic hearing, (ii) the sound of electric (CI) stimulation and (iii) the sound of combined low-frequency acoustic hearing and the CI. Most generally, low-frequency acoustic hearing and the CI combine to produce a percept closer to normal than the sound of the CI alone.

Translational research in audiology: The road not taken?

Szczepek A.

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Translational research is a branch of biomedical investigations that applies the basic research findings to the clinics and takes the clinical problems and observations to the research laboratory for further studies. This lecture will discuss how clinical audiology could benefit from basic research in hearing science. Ototoxicity will be used as an example. In addition, the advantage of consistent usage of terms "translational research in audiology" or "translational audiology" for research dissemination and education as well as the implementation of these terms in MeSH (Medical Subject Headings) will be demonstrated and examined.

Value of auditory (acoustic) implants

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During recent decennia, different types of (semi) implantable hearing devices have been released commercially. Most of these auditory implants have been applied successfully in patients who cannot or don't benefit enough from conventional solutions. Few studies have been published comparing these relatively new auditory implants (middle ear implants, percutaneous bone-conduction implants, passive and active transcutaneous bone-conduction implants). Furthermore, often, new devices or updates of existing devices are released without appropriate clinical trials. So, clinics have to experience themselves which devices are the most effective ones. Long-term data on stability and cost-effectiveness evaluation are often missing as well. Through the years, several acoustic devices have been taken off the market because of insufficient benefit. Consensus statements and overviews of what we have learned through the years might help the clinician with counselling patients. The present status of a multi-stakeholder approach will be presented. As a rather new form of an expert opinion, an independent website has been released in 2014, aiming at a classification system of these new amplification options. Objective data have been used regarding the capacity of the devices. The information of the website is not based on subjective data (patient's opinions) because such measures might easily be biased (e.g. Cox et al., 2007). The website is meant for professionals, counselling patients. The classification system is uniquely based on the available 'dynamic range of hearing' after implantation and results in appropriate application ranges in dB HL, for all acoustic implants on the market, enabling a comparison between devices. This classification system has been validated recently and will be discussed in detail.

What limits do we find in audiology and balance pathology?

Ramos A.

Las Palmas University, Las Palmas de Gran Canaria, Spain

Background: We describe an intervention to control disabling Meniere disease in 10 patients with severe-to-profound hearing loss combining a labyrinthectomy and cochlear implant to restore hearing. **Methods:** Following a thorough preoperative assessment and consenting process, 10 patients underwent labyrinthectomy of the affected ear with simultaneous cochlear implantation. In all cases a slim perimodiolar CI632 electrode was used. **Results:** All patients achieved control of Meniere's attacks with improved hearing rehabilitation. In 2 cases oscillopsia was noted by both patients, and no further side effects were observed. **Conclusions:** successful treatment of patients with Severe-to-profound hearing loss and Meniere disease, by simultaneous surgical labyrinthectomy and cochlear implantation is presented. We propose this as a potential management strategy in this rare but complex group of patients in whom all less destructive measures have failed.

Workshops

Assessment of hyperacusis: Audiological & psychometric evaluations complemented by in-depth clinical interviewing

Aazh H.

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By the end of this workshop participants will be able to take a clinical case history for their hyperacusis patients. They will be able to modify the procedure for pure-tone audiometry and uncomfortable loudness levels tests in patients with tinnitus and/or hyperacusis in order to avoid the experience of discomfort during testing. The clinical application of a wide range of self-report questionnaires in assessment of hyperacusis and sound sensitivity will be reviewed. In addition, by the end of this session, participants should be able to select and apply a wide range of specialist self-report tools for screening of underlying panic disorder, phobia, obsessive compulsive disorder, generalised anxiety, suicidal ideations, health anxiety and depression and make appropriate onward referral to mental health services for further investigations and treatment.

Panel Discussions and Special Sessions

Session: Advances in audiological technologies related to hearing screening practices. Pitfalls, suggestions and solutions

Advances and pitfalls in the detection of hearing loss via otoacoustic emissions

Hatzopoulos S.

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The presentation provides information on a number of developments in the area of Hearing Loss Identification via Otoacoustic emissions. It is based on 3 peer-review publications in the period 2020–2022.

The first study refers to data related to the pitfalls of hearing loss detection via the Accuscreen hearing screening device. The purpose of this prospective, nonrandomized, and controlled study was to evaluate the screening performance obtained from recent and older versions of the Otometrics Accuscreen OAE screening device in comparison with the Otodynamics ILO-292 OAE system, which has been used as the gold standard. Testing included otoscopic assessment, pure tone audiometry, tympanometry, and transiently evoked OAE (TEOAE) recordings. There was about a 77% agreement between the two versions of the Accuscreen device. Agreement between the two Accuscreen devices and the ILO was approximately 70% for the old and 80% for the new. The newer version of Accuscreen seems to perform better than the old, being more consistent with the reference ILO system and with the audiometry profiles of the tested subjects. In order to set robust standards for OAE evaluation and analysis, additional studies comparing different OAE hearing screening systems are needed.

The second study introduces data from a new TEOAE stimulus paradigm, using a tympanometry pressurizing probe. Recently, Interacoustics presented a new otoacoustic emission protocol where the probe pressurizes the ear cavity, thus eliminates the risk of non-assessment (REFER outcome) due to a negative middle ear pressure. This study evaluated the characteristics and the performance of this new protocol on a newborn well-baby population. Methods: One hundred sixty-three newborns (age 2.7±1.1 days) for a total of 294 ears were assessed randomly. Transiently evoked otoacoustic responses were acquired by the Titan device (Interacoustics), using the default and a pressurized TEOAE protocol. The data were analyzed in terms of signal to noise ratios (S/Ns) at 5 frequencies, namely, 0.87, 1.94, 2.96, 3.97, and 4.97 kHz. To assess any possible gestational age (GE) effects on the TEOAE variables, the responses were subdivided in 4 different age subgroups. Results: There were no significant differences between the left and right ear TEOAE responses, for age (in days), GE (in weeks), weight (in grams), and S/N at all 5 frequencies. Considering the pooled 294 ears, paired t tests between the default and the pressurized TEOAE data showed significant differences across all 5 frequencies ($p<0.01$). The pressurized protocol generated TEOAE responses presenting larger S/Ns, and a positive additive effect of approximately 2.31 dB was observed at all tested frequencies. There were no significant GE effects on the pressurized TEOAE responses. In terms of performance, both protocols performed equally (same number of PASSes). The pressurized TEOAE protocol generates responses with higher S/Ns which might be useful in borderline cases where the middle ear status might cause a REFER screening outcome.

The third study, presents data on developments in the area of automatic TEOAE discrimination. One methodology, based on recurrence quantification analysis (RQA), can identify adult subjects presenting sensorineural hearing impairments. The paper investigates further two aspects of the previously proposed RQA-based analysis for hearing loss detection: (i) the reliability of a Training set built from different numbers of ears with normal hearing, and (ii) the threshold value of the key hearing loss detecting parameter RAD2D. Results: The Training set built from 158 healthy ears was found to be quite reliable and a similar but slightly minor performance was observed for the training set of 118 normal subjects, used in the past; the proposed ROC-curve method, optimizing the values of RAD2D, shows improved sensibility and specificity in one class discrimination.

Session: French Society of Audiology (FSA) Hearing Impairment in a Society I

Arterial spin labeling brain MRI (ASL-MRI) study to evaluate the impact of deafness on cerebral perfusion in 79 children before cochlear implantation

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Objectives: We had investigated differences in cerebral blood flow (CBF) at rest prior to implantation in children with congenital deafness compared to normally hearing children. **Material and methods:** Retrospective study included 79 children, candidates for cochlear implantation between 2012 and 2018. All patients underwent a brain and inner ear MRI, a routine MRI protocol including ASL-MRI. The median age at time of MRI scan was 3.2 years (range 0.5 to 15.8 years). A control group was composed of 86 normally hearing children with a median age at time of MRI scan of 2.9 years (range 0.5 to 13.0 years). Participants were divided into 3 subgroups based on their age at time of MRI. A subgroup under 2 years of age was composed of 28 patients and 33 controls. A subgroup aged between 2 and 5 years of age was composed of 26 deaf patients and 20 controls. A subgroup older than 5 years of age was composed of 25 deaf patients and 33 controls. For children over 5 years old, prior to cochlear implantation (CI) and following hearing aid rehabilitation the mean intelligibility score was of 64.5±32%, and was 92±11.5% twelve months after CI. There was no correlation between age and intelligibility scores either before or after cochlear implantation. **Results:** In deaf children older than 5 years old, results showed a significant bilateral hypoperfusion in temporal regions, and a significant hyperperfusion of occipital regions. Furthermore, whole brain voxel-by-voxel correlation analysis between preoperative rest-CBF and oral intelligibility scores at 12 months post-implantation, showed significant negative correlation localized in the occipital regions. Finally, when comparing mean relative perfusion across ages in patients and controls, we observed that temporal perfusion increased with age in normally hearing children, although it remained stable in deaf children. **Conlusions:** Children who performed worse in the speech perception test one year after implantation were those presenting higher preoperative CBF values in these occipital regions. We showed a critical period around 4 years old, where in the context of auditory deprivation, there is a lack of synaptic activity in auditory regions. These results support the benefits of early cochlear implantation to maximize the effectiveness of auditory rehabilitation and to avoid cross-modal reorganization.

Atraumatic cochlear implant insertion with the robot-assistance of RobOtol®

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Objectives: The reduction of the intracochlear trauma during cochlear implant insertion has become the standard care in cochlear implantation surgery with the objective of maintaining the integrity of inner ear structures. **Material and methods:** RobOtol®(Collin, Bagneux, France) is a robotic arm device, designed to assist middle ear surgery and cochlear implantation and tele-operated by the surgeon through a SpaceMouse® (3Dconnexion). All kinds of electrode arrays of the different brends (Advanced Bionics, Cochlear, Medel, Nurotron, Oticon) can be adapted to the robotic arm. RobOtol® allows a slow and constant insertion speed of the electrode array into the cochlea. It also offers the possibility to modify the insertion axis following the optimal axis of insertion within the basal turn of the scala tympani. **Results:** According to the robotic-assistance procedure, the rate of translocations from scala tympani towards the scala vestibuli was dramatically reduced depending on the electrode array type. **Conclusions:** A robotic assistance for cochlear implantation could reduce the intracochlear trauma which is evidenced even when it is manually performed by experienced surgeons.

Facial nerve stimulation in adult cochlear implant recipients with a far-advanced otosclerosis

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Objectives: Cochlear implantation (CI) is a treatment option in far-advanced otosclerosis. Previous studies in small population report higher risk of facial nerve stimulations (FNS) in these patients that can affect hearing outcomes. The aim of our study was in cochlear implanted patients for a far-advanced otosclerosis to study the FNS occurrence by correlating on pre-operative CT-scan extension and location of otosclerotic lesions to FNS, and to evaluate its impact on short- and long-term hearing outcomes. **Method:** Among 2270 adult cochlear implanted patients (1991–2017), 100 patients presented FAO (4.4%). Demographic data, speech performance, occurrence of FNS and extension of otosclerosis on pre-operative CT scan were retrospectively analysed in 91 ears (76 implants). The mean follow-up duration was 13±18 years. Patients were implanted with straight (50%) and perimodiolar (50%) electrodes of the four brands of devices. **Results:** The prevalence of FNS was 21%. FNS appeared in the first month after CI, between 1 and 6 months, 6 and 12 months and after 1 year in 21%, 26%, 21% and 32% of cases respectively. The cumulative incidence at 15 years was 33%. Extension of otosclerotic lesions was more severe in ears

with FNS compared to those without FNS with 13 ears (68.5%) having a stage III, 5 ears a stage II (26.5%) and one ear a stage I (5%) vs 18 (25%), 27 (37.5%) and 27(37.5%) in ears without FNS (p<0.001). Ossification of the round window was also different between the two groups (p<0.05). Surprisingly, the extension and location of otosclerotic lesions observed before implantation were not different between group of patients with late FNS (after 1 year) and group with early FNS. Thirteen ears (68%) were implanted with a straight electrode in the group with FNS vs 32 (44%) in the group without FNS, but this difference was not significant. FNS did not impact hearing outcomes at 1-year post-CI, despite an association with a lower percentage of activated electrodes (p<0.005). Long duration of profound hearing loss and previous stapedotomy were negatively associated with speech performance at 1-year post-CI. FNS were associated with a decrease of speech performance over time for monosyllabic words in quiet (p<0.001) and sentences in noise (p<0.05, linear mix model). **Conclusions:** Cochlear implanted patients for advanced otosclerosis show greater risk of developing FNS, which affect speech performance over time, likely due to a higher percentage of deactivated electrodes. High Resolution CT-scan is an essential tool allowing prediction of FNS occurrence.

Is the Carhart notch a predictive factor of hearing results after stapedectomy ?

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Objective: The Carhart notch (CN) is a depression in the bone-conduction audiogram of patients with clinical otosclerosis, maximal at 2 kHz. The middle frequencies from 0.5 to 2 kHz, which correspond to the resonance frequency of the middle ear, can be substantially improved following successful stapes surgery. However, definite criteria for the detection of a CN remain unclear. The main goal of our study was to determine whether preoperative audiological assessment as the presence of a CN were predictive factors for postoperative hearing results such as BC threshold improvement. **Method:** Retrospective audiometric database and chart review in one tertiary referral center performed with the aim of assessing whether the presence of a CN could be predictive of results after stapes surgery in otosclerosis, through improvement in BC thresholds. An assessment of hearing status was performed before and after surgery at 4 months and at 1 year. We used a 4-frequency pure-tone average for AC and BC thresholds (0.5, 1, 2, and 4 kHz). Only AC and BC results that were obtained at the same time postoperatively were used for calculation of the postoperative air-bone gap (ABG). BC threshold improvement, i.e. overclosure, was measured by the preoperative minus the postoperative pure-tone BC average. Audiometry was assessed according to the American Academy of Otolaryngology Head and Neck Surgery guidelines except for thresholds at 3 kHz which were substituted in all cases with those at 4 kHz. This was necessary because 3 kHz measurements were not performed at the beginning of this study. **Material:** Nine hundred and thirty-one cases of stapes surgery over a period of 25 years benefitted from an audiological assessment before and 4 months after surgery. A CN was considered present when the BC threshold at the notch frequency (0.5, 1 or 2 kHz) exceeded the mean thresholds at higher and lower adjacent frequencies by at least 7.5 dB. BC threshold improvement was better at 2 kHz (+14.1±12.5 dB vs. +12±13.2 dB) and lower at 4 kHz (+3.6±13.5 dB vs. +11±14.7 dB) for the CN+ group compared to the CN– group. Moreover, sensorineural hearing loss was more frequent in the CN+ group than in the CN– group. **Results:** A CN was observed in 495 (53.1%) of the 931 surgical cases in the preoperative audiogram according to our definition. Notches were distributed according to the peak frequency as follows: 273 (29.2%) surgical cases at 2 kHz, 44 (4.7%) at 1 kHz, and 178 (19.1%) at 0.5 kHz. The CN depth means (corresponding to the difference of mean adjacent thresholds minus CN threshold) were: 13 ± 4.7 dB for 2 kHz CN, 11.3±4.4 dB for 1 kHz CN, and 11.5±4.7 dB for 0.5 kHz CN. Improvement of BC thresholds 4 months after surgery were significantly different if a CN was observed on preoperative audiogram (495 cases with CN: CN+ group) or not (436 cases without CN: CN– group). BC thresholds improvement for the CN+ group were better at 0.5 and 2 kHz. **Conclusions:** Carhart notch or more appropriately the Carhart effect was observed at a wide range of frequencies, predominantly at 2 kHz. However, it is not an indicator of successful surgery. We identified preoperative audiological factors influencing BC improvement: 4 kHz BC improvement was significantly lower in case of preoperative Carhart notch or in presence of an AC–notch at 2 kHz. These findings should alert the clinician to a mixed hearing loss with preoperative sensorineural hearing loss (SNHL) or to a higher incidence of postoperative SNHL.

New indications for hearing aids in children: interests and limitations

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Objectives: The introduction of neonatal screening for deafness has provided early management of severe or profound bilateral deafness. This screening has also allowed an early identification of moderate and mild bilateral deafness and unilateral sensorineural deafness, leading to think about the age of fitting, the acceptability of hearing aids and even amplification relevance. In addition, advances in electrophysiology, imaging and genetics have made possible to characterize neural disorders, including auditory neuropathies, for which amplification management requires precautions. Here, we aim to study the acceptability of hearing aids in children with unilateral deafness. **Material and Methods:** Retrospective study conducted in a group of 50 children with of unilateral deafness. **Results:** The analysis of fitting acceptance shows that the average age of fitting in this population is 8.1 years (±2.8). Paradoxically, unilateral total deafness and aplasia were the least accepted devices. Out of 50 children, 39 were fitted with a hearing aid and 10 of them abandoned the fitting at the age of 14 years (±3.5 years). Hearing aid use is often limited at school. However, an analysis conducted on 39 children with unilateral deafness confirms the interest of hearing aids for intelligibility in noise, sound localization, and fatigue decrease at the end of the day. Through listening effort measurements, it was found that these children produce a higher listening effort than normal hearing children, and this was also observed for mild to moderate deafness in 2020 in a study on 23 children. Despite the beneficial effect of amplification in children with bilateral mild hearing loss, we found a high variability in hearing aids use. **Conclusions:** Neonatal screening allows early management of hearing disorders, and

has also diversified the population of children to be fitted with specific approaches that remain to be perfected.

Reliability of remote pure tone and speech in noise audiometry of cochlear implant recipients with Cochlear Remote Check app

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Objectives: Follow-up of increasing cohorts of cochlear implant recipients is a current challenge for most of cochlear implant centers. Recently Cochlear company developed a smartphone app called Remote Check to perform remote follow-up of cochlear implant recipients. Among various functions, Remote Check can directly test patients for Pure Tone Audiogram (PTA) and Digit in Noise (DIN) through the wireless connection of the processor. The aim of the study was to assess the test-retest reliability of remote PTA and DIN, and to compare results to face-to-face (F2F) results using the same tests. **Material and methods:** A prospective monocentric study was conducted on 16 subjects using a Cochlear Nucleus 7 CP1000 or KANSO 2 processor. We performed two sets of tests for test re-test reliability (PTA and DIN) in both F2F and remote conditions. In this last condition, Remote Check app was used with iOS compatible smartphone, and F2F evaluation was performed in a calibrated free-field. For PTA assessment 250, 500, 750, 1000, 2000, 3000, 4000 et 6000 Hz thresholds were analyzed. In addition, two questionnaires were used: the SSQ12, a quality-of-life questionnaire, and the SUTAQ, a telemedicine acceptability questionnaire. **Results:** Test-retest evaluation showed a fair correlation of PTA and DIN results using Remote Check ($R2$=0.67 and 0.73 respectively, p<0.01 for each) and F2F evaluation (PTA: $R2$=0.58, p<0.05; DIN: =0.78, p<0.01). Test-retest correlation was lower for PTA when performed F2F compared to remote evaluation. There was no correlation between F2F and remote evaluation for PTA ($R2$=0.05, p>0.05) or DIN ($R2$=0.27, p>0.05). Quality-of-life evaluated with SSQ12 was similar in our sample than in previously published results. The acceptability of the telemedicine procedure evaluated with the SUTAQ is similar to other telemedicine programs for diabetes, COPD, and heart failure. **Conclusions:** Remote Check App provides reproducible data for PTA and DIN evaluation. However, the data collected with the App are not identical to F2F measurements. Therefore, the user has to be aware that Remote Check data can be used for follow-up only by comparison with dataset obtained with the same App.

Testing speech intelligibility in noise with the VRB test: Results of a large scale prospective observational study in normal hearing and hearing impaired adults

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Objectives: In order to quantify intelligibility in noise, a new test has been developed, named VRB (which stands for "Vocale Rapide dans le Bruit", an adapted French version of the so-called "Quick Sin" Test). To establish references in hearing impaired people, it was necessary to conduct a large-scale study, involving a group of adult patients with varying degrees of hearing loss. **Material and methods**: We designed a prospective observational study in normal hearing (NH) and hearing impaired (HI) adults. Data were collected between June 2019 and January 2021 and consisted in: pure-tone air conduction thresholds for each ear using headphones for audiometric frequencies 0.5, 1, 2, 4, 6, and 8 kHz. Unaided monosyllable word recognition in quiet was measured in sound field at 65 dBA using monosyllable words from Lafon, in binaural condition. Unaided sentence recognition in noise was measured in sound field using the VRB test (binaural performance). **Results:** 639 listeners across 16 hearing centers completed the study, with the following breakdown by degree of hearing loss, based on binaural pure tone average (PTA): 187 normal-hearing (NH; PTA ≤20 dB HL) subjects, 146 subjects presenting mild hearing loss (Mild HL; 20< PTA ≤40 dB HL), 213 with a moderate grade 1 hearing loss (Mod HL1; 40< PTA ≤55 dB HL), and 93 with a moderate grade 2 hearing loss (Mod HL2; 55< PTA ≤65 dB HL). The mean SRTs and 95% confidence intervals around the mean were: 0.8 [0.6; 1] dB, 6.6 [6; 7.2] dB, 11.4 [10.9; 12] dB, 17.2 [16.6; 17.8] dB, for the NH, Mild HL, Mod HL1, and Mod HL2 groups, respectively. The medians were 0.7, 5.9, 11.1, 18.9 in the 4 groups respectively. We found that the relationship between PTA and SRT were weak, with a maximum R-square of 0.3 between PTA in the best ear and SRT for the NH group. The other R-squares were 0.02, 0.23 and 0.04 for the Mild HL, Mod HL1, and Mod HL2 groups, respectively. We also found weak relationship between vocal score in quiet at 65 dB and SRT in noise. **Conclusions:** Our results confirm that the traditional way of assessing hearing loss in quiet (tonal and vocal audiometry) does not give a complete overview of hearing impairment: given a PTA value, there is a high variability of scores in noise, which can efficiently and quickly be measured in French speaking patients by the VRB test.

Training outcomes for audiology students using virtual reality or traditional training methods

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Objectives: Due to limited space and resources, it can be difficult to train students on audiological procedures adequately. In the present study, we compared audiology training outcomes between a traditional approach and a recently

developed immersive virtual reality (VR) approach in audiology students. **Material and methods:** Twenty-nine first-year audiology students participated in the study; 14 received traditional training ("TT group"), and 15 received the VR training ("VRT group"). Pre- and post-training evaluation included a 20-item test developed by an audiology educator. Post-training satisfaction and self-confidence were evaluated using Likert scales. **Results:** Mean post-training test scores improved by 6.9±9.8 percentage points in the TT group and by 21.1±7.8 points in the VRT group; the improvement in scores was significant for both groups. After completing the traditional training, the TT group was subsequently trained with the VR system, after which mean scores further improved by 7.5 points; there was no significant difference in post-VR training scores between the TT and VRT groups. After training, the TT and VRT groups completed satisfaction and self-confidence questionnaires. Satisfaction and self-confidence ratings were significantly higher for the VR training group, compared to the traditional training group. Satisfaction ratings were "good" (4 on Likert scale) for 74% of the TT group and 100% of the VRT group. Self-confidence ratings were "good" for 71% of the TT group and 92% of the VRT group. **Conclusions:** These results suggest that a VR training approach may be an effective alternative or supplement to traditional training for audiology students.

Session: French Society of Audiology (FSA) Hearing Impairment in a Society II

Cervical vestibular evoked myogenic potentials (c-VEMPs) in healthy children: bone vs air conduction results

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Objectives: Cervical vestibular evoked myogenic potentials (c-VEMPs) are feasible and reliable electrophysiological measures that are widely used in adults for evaluating the otolith vestibulospinal function. In children, normative values are still lacking. This study aimed to fully characterize c-VEMPs for bone conduction (BC) and air conduction (AC) c-VEMPs in healthy children. **Material and methods:** We used a recording protocol and analysis adapted to children as young as 2 months of age. Otolith receptors were stimulated with tone burst (750 Hz, 6.6 ms duration, 4.1 pps) delivered either by BC (B71vibrator on the mastoid) or AC (headphones). The c-VEMPs were normalized using EMG quantification from individual-trace EMGs. Measurements included N-P wave amplitude ratio, threshold, as well as P- and N-wave latency. 118 healthy (=236 ears) children with bilateral type A tympanogram (aged 2 months to 15 years; mean ±*SD*: 8.7±4.5 years; 60 boys) were included. **Results:** AC and BC c-VEMP amplitude ratios were significantly correlated (r=0.6, p<0.001) with no significant difference in the amplitude ratio (p>0.05) between BC and AC. There was no significant difference between BC and AC c-VEMP. Finally, there was no relevant difference (p=0.69) for P- and N-wave latency between BC and AC. **Conclusions:** Results indicate that BC and AC stimulation can be used indifferently for c-VEMP recordings up to 15 years of age but not in adults. Therefore, BC c-VEMP test should be part of the vestibular evaluation test battery in children with balance disorders.

Clinical utility of cortical potentials in programming cochlear implant in children with complex needs

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Introduction: Over the past decade, indications for cochlear implantation have changed dramatically. Research has demonstrated that early intervention yields better speech and language outcomes, and that these advantages persist over time. As a result, children are now being implanted as young as 3 months of age. It has also been demonstrated that cochlear implantation can improve the quality of life in multi-handicapped children, even if they do not acquire spoken language. The widening of indications, however, has raised new challenges for cochlear implant fitting procedures, which are primarily based on subjective measures of loudness. Sufficient and reliable subjective measures can be difficult to obtain in young infants as well as children with cognitive and developmental delays. While some objective measures such as electrically evoked compound action potential (ECAP) can be used to guide the implant fitting process, it has largely been demonstrated that there is a poor correlation between ECAP and behavioural measures. Furthermore, studies have revealed that for most clinicians, objective measures do not play a large role in determining map parameters. Without subjective input from the patient, it is difficult confirm that the cochlear implant is delivering sufficient stimulation. Electrophysiological measures, such as Cortical Auditory Evoked Potentials (CAEP) are one objective way to evaluate audibility. While these measures have been applied to validate hearing aid fitting in infants and patients unable to participate in behavioural testing, they are not widely used in the implanted population. **Objectives:** The objective of this project was to explore whether CAEP can be used to improve cochlear implant fitting, particularly in patients with complex needs. Feasibility in terms of technical parameters, patient factors and ease of interpretation of results were the primary focus. **Material and methods:** CAEPs were tested using the HearLab Cortical Evoked Potential Analyzer. The HearLab was designed for clinical use and is intended to simplify the procedure such that both the testing and analysis of responses can be performed by clinicians with limited experience in electrophysiology. The Aided Cortical Assessment (ACA) module offers the option to test the phonemes /m/, /t/, /g/ and /s/ at three intensity levels 55, 65 and 75dB. A series of implanted patients were tested at approximately 3 months post-implantation, to establish a baseline. The test protocol was also applied in the case of one patient, and the results were integrated into the fitting procedure. **Results**: Most patients tolerated the test procedure well, regardless of age, although patient fatigue was an important factor when testing both ears. The primary challenges in obtaining results were related to electrical interference, which either inhibited testing altogether or posed a challenge for interpretation of results. CAEPs at three months

post-implantation were variable across patients, and while most patients exhibited some cortical responses, they did not necessarily exhibit responses to all stimuli. There were two cases in which all CAEPs were absent and increasing the stimulation did lead to the appearance of responses in these cases. **Conclusions:** The use of CAEPs can provide additional information to guide cochlear implant fitting. However, results should be interpreted with caution, particularly in the early months following implantation. A well-defined protocol is necessary to streamline the integration of these measures into regular clinical practice.

Comparison of the French Matrix test outcomes between two conditions of administration in free field: Results of a large scale prospective observational study in normal hearing and hearing impaired adults

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Introduction: In clinical practice, speech understanding in noise is most often evaluated using co-located speech and noise (i.e., without spatial cues). The French Matrix test was indeed validated in this condition of administration. Yet, most hearing aid centers in France are equipped with five-loudspeaker arrays, which allows for speech to be presented from a single loudspeaker directly in front of the listener (0° azimuth) and noise to simultaneously presented from 4 loudspeakers (45°, 135°, 225°, and 315° azimuth; "diffuse noise"). This configuration is meant to be more representative of «ecological condition». **Material and methods:** We designed a prospective observational study in normal hearing (NH) and hearing impaired (HI) adults. Data were collected between June 2019 and December 2020 and consisted in: pure-tone air conduction thresholds for each ear using headphones for audiometric frequencies 0.5, 1, 2, 4, 6, and 8 kHz. Unaided monosyllable word recognition in quiet was measured in sound field at 65 dBA using monosyllable words from Lafon, in binaural condition. Unaided sentence recognition in noise was measured in sound field using the French Matrix (binaural performance). **Results:** 297 listeners across 9 hearing centers completed the study. Unaided SRTs in diffuse noise were significantly correlated with PTA thresholds, age at testing, as well as word and phoneme recognition scores in quiet. Stepwise linear regression analysis showed that SRTs in diffuse noise were significantly predicted by a combination of PTA threshold and word recognition scores in quiet. SRTs were measured in co-located and diffuse noise for 65 listeners (13 NH, 22 Mild HL, 19 Mod HL1, and 11 Mod HL2). With co-located noise, the mean SRT and standard deviation was −4.2±1.1, 0.2±3.2, 2.9±2.6, and 8.4±7.0 dB for the NH, Mild HL, Mod HL1, and Mod HL2 groups, respectively. With diffuse noise, the mean SRT and standard deviation was −8.9±1.4, −2.4±4.6, 1.9±4.3, and 8.8±9.2 dB for the NH, Mild HL, Mod HL1, and Mod HL2 groups, respectively. A RM ANOVA with noise type (diffuse, co-located) as the within-subject factor and hearing status group (NH, Mild HL, Mod HL1, Mod HL2) as the between-subject factor showed significant effects for noise type [$F(1, 61)=30.3$, $p<0.001$] and subject group [$F(3, 61)=15.3$, $p<0.001$]; there was a significant interaction [$F(3, 46)=4.1$, $p=0.010$]. Post-hoc Bonferroni pairwise comparisons showed that SRTs in diffuse noise were significantly lower than SRTs in co-located noise only for the NH and Mild HL groups ($p<0.05$ in both cases). For diffuse noise, there were significant differences in SRTs among all groups; for co-located noise, there was a significant difference in SRTs among all groups, except for between the Mild HL and Mod HL1 groups. Linear regression analysis showed a significant correlation between SRTs in co-located and diffuse noise ($r^2=0.71$, $p<0.001$). **Conclusions:** The results are consistent with previous studies that found that hearing-impaired listeners had greater difficulty using spatial cues to segregate speech and noise. While diffuse noise may not be suitable for clinical evaluation of speech understanding in noise in hearing-impaired listeners, it may provide additional insights into their "real-world" speech understanding in complex listening environments. Moreover, as our study provides the range of possible values of unaided SRTs, they may serve as references for comparison with aided SRTs, more likely to be measured in a diffuse noise setup than in a co-located noise one.

Contributions of new medical genetics technologies in early hearing loss

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Objectives: Genetic consultation is now included in the management of early hearing loss in many countries. In this presentation we will assess the contributions of advances in medical genetics but we will also address the difficulties there cause both medically and ethically. Methods: Review study. **Results:** In twenty-five years more than 150 genes involved in isolated early hearing loss have been cloned and hundreds of rare forms of syndromic hearing loss have been described. Advances in knowledge combined with technological advances in DNA sequencing allow more genetic diagnosis today. **Conclusions:** In the last twenty years, the field of genomics is one of the sciences in which the advances have been the most spectacular. These technological advances have enabled tremendous progress in the research and treatment of genetic diseases.

Electroacoustic changes and patterns of 3T-3D flair MRI of endolabyrinthin spaces in Ménière's disease

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Objective: Analysis of labyrinthine 3T-3D flair MRI changes in patients suffering from confirmed Menière's disease (Md). **Material and methods:** Patients with definite Md were fully

explored in a prospective study, using auditory and vestibular tests on the one hand, and labyrinthine 3T-3D flair MRI, during or near (<7 days) an attack of the disease, on the other hand. In particular, they all had pure tone and speech audiometry, either transient otoacoustic emissions or distortion product otoacoustic emissions. The cubic distortion tone at 2f1-f2, around 1kHz with equilevel f1 and f2, and f2/f1@1.2, was recorded in terms of intensity and phase. An acoustic phase shift >40° was considered significant, with or without position changes. Cochlear potential as recorded through electrocochleography were also analyzed, the ratio SP/AP ≥40% being considered abnormal. Vestibular testing used caloric videonystagmography, and vestibular Evoked myogenic potentials. MRI images were acquired 4 hours after injection of gadolinium, using FLAIR sequences in a 3T magnetic field. Endoymphatic hydrops was defined according to the ratio of the volumes between saccule and utricule (SURI), when the saccule was greater than the utricule, or when both structures were convergent and indistinguishable. **Results:** 50 patients underwent this prospective diagnostic protocol after giving their approval for participating. The sex ratio, female/male was 29/21, and the mean age 52±15 year-old. They all had objective alteration of their functional exploration confirming the diagnosis of Md. Labyrinthine 3T-3D flair MRI was interpreted as abnormal in 39 patients (78%). **Conclusions:** Coupling clinical examination, electroacoustic auditory and vestibular explorations together with labyrinthine 3T Flair MRI, shows that hydrops can nowadays be visualized in a majority of cases, at least in symptomatic patients.

Identification of subpopulations of auditory neurons using Auditory-evoked Brainstem Responses and masking

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Objectives: Auditory pathways process information from distinct subpopulations of cochlear neurons that encode sounds within specific intervals of levels. The design of standard audiological tests, among which Auditory Brainstem-evoked Responses (ABRs) would be the most suitable, is such that the subpopulation of high-threshold auditory neurons does not contribute to thresholds, and contributes little to suprathreshold waveforms. Hence, the name 'hidden auditory neuropathy' is given to conditions in which the disorder targets high-threshold auditory neurons. The aim of this work is to design an ABR technique sensitive to this type of disorder. **Material and methods:** In the reported study, noise-induced synaptopathy was replicated in CBA/JRj mice (2-h exposure to octave-band intense sound at 94, 97 and 100 dB SPL), inducing no visible hearing loss despite the decrease in ribbon-synapse number for the 97 and 100 dB exposures. The ABRs were collected using a simultaneous broadband-noise masker just able to erase the ABR response to a 60-dB tone-pip, thus removing the contributions of low-threshold cochlear neurons and the circuits to which they connect. Tone-pip intensity was then increased for eliciting reemerging ABRs (R-ABRs), made only of contributions from cochlear neurons for which masking was insufficient, thus likely the high-threshold ones. **Results:** In the ears with synaptopathy, i.e., most of those exposed to 97 dB SPL and all ears exposed to 100 dB SPL, R-ABRs from the overexposed region vanished, whereas standard ABR characteristics hardly differed from controls. Thus, R-ABRs afforded an individual noninvasive marker of normal-auditory-threshold hidden auditory synaptopathy. **Conclusions:** The simple paradigm of R-ABR detection has been transposed to volunteers with normal auditory thresholds, otoacoustic emissions, standard ABRs, normal acoustic reflexes and speech-in-noise detection, no risk factor such as exposure to intense sounds and no auditory complaint. Commercial equipment that delivered click stimuli and ipsilateral broadband noise was used for this purpose. Normative data from a sample of 50 young adults will be presented. So, the simple paradigm of R-ABRs should readily contribute to exploring subpopulations of auditory neurons in humans at risk.

Intelligibility and audibility at hearing aids output in noisy environment: Class 1 and Class 2 performance comparison

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Objectives: Speech intelligibility in noise is a major problem for the hearing impaired even with hearing aids. The hearing aid manufacturers' challenge is to propose signal processing strategies that allow speech to emerge in complex sound environments. For this, options such as adaptive directionality of microphone systems and noise reduction are used. The most recent hearing aids use the source localization technique or artificial intelligence to detect useful signals (speech) from those caused by nuisance (noise). Once located, noises are reduced to allow the speech to emerge. Class 1 hearing aids -low-end products- regulated in the 100% health system in France have such treatment options that improve intelligibility in noise. Class 2 hearing aids -high-end products- according to the manufacturers, involve more elaborate algorithms and for a greater number of frequency channels. The objective of this study is to evaluate these options effectiveness for the two hearing aids classes. **Material:** The hearing simulation platform of the hearing aid training center of the Faculty of Pharmacy in the University of Lorraine (France) has been developed to reproduce complex sound environments and to analyze the output signals of hearing aids placed on the artificial head's ears. **Methods:** This platform allows to evaluate the Signal to Noise Ratio (SNR) indicator at the hearing aids output, for different sound environments -several incidences of the voice signal and different spatialization configurations of the noise- and for several input SNR (−6 to 9 dB) using the method of Hagerman and Olofsson (Acta Acustica, 2004). **Results:** The estimated output SNR as a function of frequency for different sound environments is compared to input SNR values. This highlights differences between classes of hearing aids for five different manufacturers, in terms of speech emergence. **Conclusions:** This work allows to discuss the comparative performance of Class 1 and 2 devices

and the algorithmic strategies of hearing aids manufacturers. It shows that all the Class 1 hearing aids even improve SNR for noisy environments. The Class 2 performance is not systematically superior to those of Class 1, depending on the manufacturer.

Maturation of the medial olivocochlear efferent system: comparing dyslexic and typically developing children

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Objectives: The present study compared the evolution of the functioning of Medial Olivocochlear System (MOCS) with age between subjects who acquire reading normally (NR) and subjects with impaired reading (RI). **Material and methods:** Two hundred and forty subjects participated in the study (120 NR and 120 RI) divided into 5 age groups ranging from 8 to 32 years. MOC function was assessed in each ear by quantifying the amount of suppression of TEOAEs by contralateral acoustic stimulation (CAS), a phenomenon known as Contralateral Suppressive Effect (CSE). **Results:** Differences in the developmental trajectory of the CSE were found. These are differences between the right and left ears within the NR and RI groups but also differences between the NR and RI groups within each ear. Thus, the asymmetry of MOC function evolves with age but in a different way depending on whether reading is correctly acquired or impaired. **Conclusions:** The maturation of the MOCS, which continues until adulthood, shows differences according to the acquisition of reading.

Speech in noise input in the traditional audiological assessment

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Objectives: The estimated worldwide hearing-impaired population is expected to reach 700 million in 2050. It's now established that hearing loss has an impact on communication in plain or challenging background, on general well-being with strong association to depression and ultimately leading to accelerated and earlier cognition decline. Therefore, it should be precociously spotted. Our study proposes to evaluate the input of the speech in noise intelligibility test in the different level of hearing losses. **Material and methods:** We studied among the 26 206 patients presenting a bothering enough hearing loss that they came, in the last two years, to consult an audiologist for a first-time hearing aid acquiring, the correlation between the PTA, speech in quiet and speech in noise test results. **Results:** The statistical analysis shows no correlation between speech in noise and PTA, nor speech in quiet. Speech in noise qualifies a segment of the population in demand of an improvement in its everyday social interaction, that would not have been otherwise qualified for a hearing aid fitting. **Conclusions:** Speech in noise should be included in our everyday audiological assessment for detecting intelligibility issues in light hearing losses.

Session: Hyperacusis & Tinnitus Management: Research Evidence Informing Best Practice

Hyperacusis & tinnitus management: Research evidence informing best practice

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In this panel discussion, some of the key management strategies for tinnitus and hyperacusis and their evidence-base will be reviewed. Advantages and shortcomings of each approach will be discussed. Participants will have plenty of opportunity to ask their questions from the panel members.

Session: IERASG The State-of-the-Art of the Auditory Waves: from hot AEP-Research to Clinical Practice

Contribution of bone conduction click-evoked auditory brainstem responses to diagnosis of hearing loss in infants in France

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Introduction: Neonatal hearing screening in France involves confirmation by a childhood hearing expert centre in case of suspected hearing loss. Although click-evoked air-conduction auditory brainstem responses (AC-ABR) are the gold standard in France, there were until recently no guidelines for bone-conduction ABRs (BC-ABR). Herein, we assessed the interest of associating click-evoked BC- and AC-ABRs for diagnostic confirmation in neonatal hearing screening. **Material and methods:** A retrospective study included 59 infant ears with conductive hearing loss referred to our department. Objective hearing thresholds were compared between click-evoked BC- and AC-ABRs on a method previously validated in a normal-hearing population. **Results:** There was a significant difference in mean threshold between AC-ABR (53.27±1.189 dBnHL) and BC-ABR (28.1±0.935 dBnHL) (P<0.001). AC thresholds ranged from 40 to 60 dBnHL while BC thresholds exceeded 40 dBnHL in only 9 ears. **Conclusions:** Using BC-ABRs could reduce the false-positive rate in neonatal bilateral permanent hearing loss screening, in complement to AC-ABRs using the same stimulus. Click-evoked BC-ABR could be contributive whenever conductive hearing loss is suspected, in complement to AC-ABR, without unreasonably increasing examination time.

Evoked auditory responses as a central pillar of advanced objective audiometry

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Evoked responses of the auditory system are central pillars for the differential diagnosis of hearing disorders during the whole lifespan. Registration of otoacoustic emissions (TEOAE, DPOAE), Click- and frequency specific evoked ABR and ASSR allow to evaluate the type and degree of hearing loss and the functional status of the auditory nerve and brainstem from the first days of life. For the extended diagnosis of central auditory processing and maturation, cortical event-related potentials (CAEP, ERP) can evaluate the rehabilitation success after provision of hearing aids and cochlear implants. The introductory lecture will provide an up-to-date overview of the state of the art and modern developments of objective audiometry. Finally, typical clinical case studies will be presented. OAE's provide important frequency-specific information about the functional status of the outer hair cells (OHC=cochlear amplifier). With help of Click evoked ABR as the gold standard the amount of hearing loss and the functional status of the auditory nerve and central auditory system can be evaluated. This is of central importance for the indication of hearing aid provision or Cochlear implantation and helps to identify retrocochlear lesions, maturational delays, central auditory processing disorders on brainstem level as well as the diagnosis of auditory synaptopathy/auditory neuropathy (AS/AN). Due to the low frequency specificity of the Click, the use of narrow-band Chirps has established itself internationally for both frequency-specific ABR and ASSR technology. Especially in the low frequency range around 500 Hz the registration of chirp evoked ABR delivers the most reliable results. The transtympanal ECochG plays a central role in preoperative objective diagnosis for cochlear implantation in challenging cases. In addition, measures of electrically evoked responses (eABR, eCAEP) can support the CI indication and evaluate the auditory function during the rehabilitation process.

Intracorporeal Cortical Telemetry (ICT): Fitting hearing prostheses with brain waves?

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Electrically evoked auditory potentials are used to predict electrical auditory thresholds in patients with a cochlear implant (CI). However, with exception of electrically evoked compound action potentials (eCAP), external (extracorporeal) EEG recording equipment is still needed to obtain later latency brainstem and (sub)cortical responses. Until now, for CI patients, only built-in (intracorporeal) back-telemetry options are limited to recordings of eCAPs, covering only recording windows of a few milliseconds (fast latency responses). Intracorporeal recordings of auditory responses beyond the cochlea are still lacking. In this research, an overview is given of previous studies, describing the feasibility to obtain longer latency cortical responses. One of the options is to concatenate interleaved short ECAP recording time windows in which extracochlear reference electrodes are dedicated to record cortical responses via the CI, while intracochlear electrodes were used for stimulation, enabling intracorporeal back-telemetry, i.e., recording of later potentials without an EEG device to assess higher cortical processing in CI recipients. To verify sensitivity and reproducibility, we have performed simultaneously extra- (with EEG device) and intra-corporeal (with CI) recordings. Our results show that it is feasible to obtain intracorporeal N1P2 slow vertex potentials with a CI and that they are similar to those obtained by conventional extracorporeal EEG recordings. Data also shows that – in analogy to ECAPs – it is possible to implement intracorporeal recording in future CI designs with recording windows beyond 500 ms. Comparison with similar other studies are addressed, confirming this proof-of-concept to apply closed-loop intracorporeal auditory cortical response telemetry (ICT) with cochlear implant devices. This research breaks new ground for next generation CI devices to assess higher cortical neural processing based on acute or continuous EEG telemetry to enable individualized automatic and/or adaptive CI fitting with only a CI.

Use of ECochG in hearing preservation CI surgeries

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Due to the increasing importance of residual hearing in cochlear implantations, a reliable instrument for monitoring residual hearing and for detecting possible critical steps during implantation would be helpful. A promising method is Electrocochleography (ECochG) which can be recorded at different sites, extracochlearly as well as intreacochlearly. Currently, intracochlear recordings are increasingly coming into focus, as the CI electrode itself can be used for recording. Now, most companies provide integrated measuring systems using the telemetric connection of the CI which can be used intra- as well as postoperatively. In this talk especially intraoperative intracochlear recordings with different CI manufacturers are discussed. First analyses indicate that in case of a deterioration of the recorded signal a certain trauma to the cochlea is likely. The relation between the behavior of the signal amplitude during CI electrode insertion and the later preservation of the residual hearing remains to be further investigated. Nevertheless, promising relations between postoperatively recorded ECochG and audiometric threshold could be detected. Thus, the recording of intracochlear ECochG could be a promising tool in supporting hearing preservation during CI surgery.

Session: ISA Sounds From Around the World

Audiology in France: What is as stake for hearing aid prescription in 2022?

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Topics: Sounds from around the world: Bringing Audiology together. **Objectives:** To describe new policies for hearing aids prescription and reimbursement in France. **Material and methods:** In 2018, the French National Health Agency set up a panel of experts in the field of Audiology to make concrete recommendations for hearing aids prescription and reimbursement. An inventory and comparison of funding mechanisms of hearing aids across European countries was made to inform reimbursement policy in France. Notably, the expert group described which auditory disorders should be eligible for reimbursement and which tests should be done prior to prescription and at follow-up. **Results:** A governmental decree was issued in November 2018, making for the first time auditory neuropathy spectrum disorders (ANSD) and auditory processing disorders (APD) eligible. Two classes of hearing aids were defined. The French society of Audiology has been providing since 2019 special training for the diagnostic procedures related to the newly eligible auditory disorders. **Conclusions:** Practical applications of the new diagnostic and prescription procedures started in 2020. Among the auditory tests now listed by the decree, speech-in-noise audiometry is strongly recommended. This will certainly allow audiologists to diagnose a greater number of patients with early presbyacusis (or presbyacusis seen at an early stage), better identify those with ANSD or APD, and conduct more robust and reliable clinical trials.

Audiology in Turkey

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Turkey has an area of 783.562 square kilometers. With a coastal length of 7.200 km, it borders the Mediterranean Sea, Aegean Sea and the Black Sea. Greece and Bulgaria neighbor Turkey in the northwest while Georgia, Armenia and Azerbaijan are its neighbors in the northeast. Turkey also borders Iran in the east and Iraq and Syria in the south. The population of Turkey is 82,003,882 (reported December 2018). The capital city is Ankara and the main language is Turkish. Education in Turkey: In 2019, there are 206 universities in Turkey; 129 of them being state universities while 77 are private universities. Istanbul University – Cerrahpaşa was established in 1453 and is the oldest university in Turkey. There are 22 faculties, 17 institutes, 7 vocational colleges. There are 62 associate degrees and 155 undergraduate degrees offered at the Istanbul University – Cerrahpaşa. There are also 403 master's and 283 doctorate programs. With a total of 903 diploma programs, there are about 180,000 students at Istanbul University – Cerrahpaşa. Audiology in Turkey: Audiology in Turkey started in 1967 at the graduate level (master's degree) with the leadership of Prof. Dr. Nazmi Hosal at Hacettepe Hospital. David Resnick Ph.D. of George Washington University and Dr. Richard Israel contributed to the development of audiology in Turkey. Dr. Richard Israel implemented and regulated audiology training programs in Turkey. Later, Marmara University (Istanbul) also initiated an audiology program at the graduate level, followed by Hacettepe University (Ankara). The first bachelor's degree program for audiology was started in Istanbul University in 2011 with Prof. Dr. Ahmet Ataş as the head of the department. Five state universities and nine private universities offer education in audiology in Turkey. The degrees currently offered in the field of audiology in Turkey are; a two-year associates degree (the academic title of 'audiometrist' is earned), a four-year undergraduate degree (Bachelor of Science (BhSc) and the title of 'audiologist' is earned), a master's degree (Master of Science (MSc)), and a doctorate degree (Doctor of Philosophy (PhD)). At the end of the 2018–2019 school year, it was estimated that there were 1200 graduates of the audiology undergraduate program that year. The audiology undergraduate program is a part of Istanbul University Faculty of Health Science. After graduation, master's and doctorate programs offer education in audiology and speech-language disorders with the program "Audiology, Speech and Language Disorders" for students who want to continue studying.„Graduates of these programs can work in hospitals, cochlear implant/hearing aid centers, rehabilitation centers, universities, and government organizations for newborn screening programs. Audiology associations in Turkey include Istanbul Association of Audiology and Speech Disorders, Audiologists Society, and OKSUD. Newborn Screening Program: The Newborn Hearing Screening Program was initiated in 2000, and has become a national practice since 2006. Currently, 95% of all newborns go through the Newborn Hearing Screening. Newborns who fail this screening and have been selected for cochlear implants can receive cochlear implant surgery at the estimated 65 cochlear implant centers across the country. The operation costs are covered by the government. Additionally, these patients are eligible to receive free rehabilitation services. School Hearing Screening: In the last 3 years, some pre-schools and elementary schools have started to perform school hearing screenings as part of a pilot study. These screenings have become a widespread practice. Geriatric Hearing Screening: Currently, there are no hearing screening programs available for Turkey's geriatric population. However, patients who need a cochlear implant can receive them free of charge. The government also partially covers the costs of hearing aids.

Following BioEthical Principles in Humanitarian Deployments (both Telemedicine and On-site)

Clark J.L.

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Objectives: When pairing global political and environmental turbulence with increasing ease of (virtual and physical) global transport, the proliferation of Voluntourism opportunities continues to rise. Voluntourism has become a more popular form of tourism for professionals and untrained individuals to charitably share their expertise in regions and countries of unrest. Inarguably, individuals choose the degree of charity they

wish to extend, but there is a deeper responsibility to abide by Ethical Principles to be followed by dedicated Humanitarian sharing their professional skills. It is often easy to lose sight of the foundational principles of Bioethics when the passion of meeting urgent needs. It has become a significant problem that some countries have issued bans on receiving certain aspects of humanitarian service provision. This talk will focus on the foundational principles of Bioethics with examples and alternative responses when a professional is compelled to volunteer in ear and hearing humanitarian deployments. **Material and methods:** The literary world provides ample documented instances of the failings on global humanitarian efforts within the current literary titles such as: "Crisis Caravan: What's Wrong with Humanitarian Aid?" (Polman, 2010); "Humanitarianism in Question…" (Barnett & Weiss, 2008); "Toxic Charity…" (Lupton, 2011); "A Bed for the Night: Humanitarianism in Crisis" (Rieff, 2002); "When Helping Hurts" (Corbett & Fikkert, 2012); and "Dead Aid: Why Aid is Not Working… in Africa" (Moyo, 2009), etc. There are a variety of examples that demonstrate the failings of voluntourism within the realm of ear and hearing care. However, as professionals, there are foundational principles of Bioethics that inarguably frame our humanitarian actions within professional conduct. This presentation not only will review some of the failings of provision of ear and hearing voluntourism in low- and middle-income regions and countries, but also suggest alternative actions as humanitarians within the context of the Foundations of Bioethics. **Conclusions:** An awareness of Foundational Bioethical behaviours will significantly reduce the number of well-meaning but short sighted voluntourists. Conversely, understanding the significance of following Bioethical standards during humanitarian deployments will not only challenge the ear and hearing care professional to be a strategically minded humanitarians, but a welcome contributor who ultimately adheres to Best Practices in low and middle income communities.

Session: Models in Audiology Education

Model of education in audiology in Italy: How far we are from it?

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The presentation provides an excursus of information related to the medical education in the Italian University system and addresses the question of how far we are set from the standards proposed by EFAS and the suggestions of other medical societies. In general, the education in Italy can be described by the following statements: The School of Audiology and Phoniatrics trains specialists who must possess the professional skills and attitude necessary to comply with national and European standards related to the clinical practice of the discipline. During the course of training, the specialist must gain theoretical knowledge, scientific and professional experience in the fields of pathophysiology, clinical and therapy of diseases of the auditory and vestibular apparatus and clinical pathophysiology and auditory communication in the pediatric and adult age. The following areas of expertise are considered: auditory pathophysiology, pathophysiology of auditory communication, functional and instrumental semeiotics in audiology and phoniatrics, clinical methodology and medical and surgical therapy in audiology and phoniatrics and rehabilitation of communication pathologies also through the prescription of prosthetic devices. They must also acquire the ability to interact positively with other health professionals and pursue the 'goal of constant updating through continuing education. Feedback on the accomplishments of each school (i.e., University clinic) is rather scarce because no standardization criteria have been accepted yet. There is more regional coordination that a precise national model.

Session: The art of reflection in hearing care and the science of clinician wellbeing

The art of reflection in hearing care and the science of clinician wellbeing

Rutherford C., Comas N.

Ida Institute, Naerum, Denmark

How can reflective practices help hearing care providers become mindful of the gap between the intention clinicians have to make appointments person-centered, and the reality of implementing person-centered care in daily clinical practice? What are the benefits of setting aside time to reflect? In this session, we will introduce self-development tools for analysis and reflective practice, including ethnographic videos and the Reflective Journal, which will help clinicians to understand their patients' needs and preferences, as well as their own professional development and wellness needs to improve the outcomes of appointments.

Session: Treatment Options for Congenital Unilateral Hearing Loss/Deafness; Sufficient Clinical Evidence?

Treatment options for congenital unilateral hearing loss/deafness. Sufficient clinical evidence?

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Unilateral hearing loss seriously affects spatial hearing as well as speech recognition in challenging environments. Secondary to that, studies showed that a subpopulation of children with congenital onset is prone to delayed language development and academic performance. Fitting a hearing device (hearing aid/bone-conduction device/cochlear implant)

is complicated as the newly aided ear has to compete with a normal hearing ear with a (unilaterally) well-trained neural system. During this round table, we discuss the application of: i) conventional behind-the-ear devices in subjects with congenital unilateral sensorineural hearing loss, ii) bone-conduction device and surgical repair in unilateral conductive hearing loss, and iii) the use of a CROS device (conventional hearing aid or bone-conduction device) and the use of a cochlear implant in unilateral deafness. Emphasis will be on binaural (fused bilateral input) versus bilateral hearing and, regarding the use of a hearing devices, on the effect of the treatment on language development. Finally, the effects of (ongoing) asymmetric hearing and (consequently) developmental plasticity on outcomes of the treatment are discussed.

Sound localization in babies with SSD

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A relatively large proportion of congenital sensorineural hearing losses (CHL) are unilateral (≈25%, Berninger et al., 2011). While outcomes with and without various interventions for pediatric unilateral CHL are described in the literature, little is known about early auditory abilities, e.g., from the neonatal period and the first few years of life. In this clinical longitudinal study, 20 consecutive children with congenital sensorineural hearing loss in one ear and normal hearing in one ear were recruited within the universal newborn hearing screening program at Karolinska University Hospital, Stockholm, Sweden. Children underwent magnetic resonance imaging and genetic testing, and participated in recordings of auditory brainstem responses, otoacoustic emissions, pure-tone audiometry and horizontal sound localization abilities from 6 months of age. Aided and unaided results from the sound localization task at 6, 12, 18, and 24 months of age will be presented and discussed, and contrasted to performance in children with bilateral normal hearing.

Session: WHO keynote address and plenary session on the World Report on Hearing

WHO keynote address and plenary session on the World Report on Hearing

Chadha S., Tavartkiladze G.

World Health Organization, Geneva, Switzerland

In 2021, WHO launched the World report on hearing which demonstrated the rising need for ear and hearing care. It outlined possible solutions to address this need and the challenges faced by the field. The report proposed the framework for integrated people-centered ear and hearing care. This includes the prioritization and implementation of an evidence-based package of H.E.A.R.I.N.G. interventions through a strengthened health system. The report makes a convincing case regarding the importance and benefit of including hearing care as part of national health plans for universal health coverage. This session will reflect on the strategies outlined in the report and share experiences from countries regarding their implementation.

Session: Electrocochleography (ECochG) – a useful tool for the advanced audiological diagnostic in challenging cases

Electrocochleography (ECochG) – a useful tool for the advanced audiological diagnostic in challenging cases

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The most significant goal of objective audiometry is to determine the type and degree of hearing loss and to evaluate the functional status of the auditory nerve and ascending auditory pathways. While the registration of Click and frequency specific evoked ABR is the gold standard of objective audiometry, the electrocochleography (ECochG) plays a central role to evaluate the functional status of the sensory cells as well as the auditory nerve in the near field of the cochlea in difficult audiological cases.

Especially in the context of a safe indication before cochlear implantation, it is useful to perform a transtympanic ECochG. It is particularly useful for patients with bilateral or single-sided deafness with unclear residual hearing and/or signs of pathological changes of the auditory nerve in cases of auditory synaptopathy/auditory neuropathy (AS/AN), after acoustic neuroma surgery, inner ear or auditory nerve malformations. The main advantage of the ECochG is, that the sensory and neural components of the inner ear can be measured in the near field and separately evaluated largely free of EEG interference or problems of overhearing.

If no or only strongly pathologically altered compound action potentials (CAP) can be obtained with acoustic stimulation, the use of a transtympanic eeABR can be a useful tool to evaluate the functionality of the auditory nerve and the central auditory processing at the brain stem level preoperatively to Cochlear Implantation. Especially in difficult clinical cases this technique can provide important indication criteria or prognostic factors regarding the rehabilitation outcome after cochlear implantation.

The overview lecture presents the physiological basics of ECochG, the practical implementation as well as the interpretation of findings on the basis of clinical case studies.

Oral Presentations

A comparison of first and second ear performance of bilateral CI users with prolonged intra-implant interval

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Objectives: To evaluate auditory perception and user preferences of bilateral CI users with prolonged intra-implant intervals after one to four years of use of their sequential implant. **Material:** Clinical reports; Implant sound field test equipment; Telephone interview with parent; Categories of Auditory Performance 2 (0–9 categories). Demographics: 42 Med-El CI users with a mean age at first ear implantation of 2 years (range 1–15 years) were implanted to the second ear after a period varying from 3–19 years with a mean intra-implant interval of 9 years. 79% of first implants were to the right side. The mean age at second ear implantation was 11 years (range 5–31 years). 6 used their second implant for 1 year, 19 for 2 years, 6 for 3 years and 11 for 4 years. **Background:** Bilateral implantation for children under age 4, in Turkey, was only approved in late 2016, this is why CI users included in this study were originally unilateral. CI users who experience non auditory stimulation before perceiving sound as loud may benefit from triphasic pulses, a feature exclusive to Med-El. **Methods:** For this retrospective study files of bilateral, sequential CI users, regularly fit and followed up at MEDers, Kadıköy, Istanbul office, were investigated. Stimulation mode used for each ear, biphasic or triphasic was recorded. Most recent implant sound field thresholds across 6 frequencies (0.25–6 kHz) for first and second ears were compared. Audiologists familiar with the CI users, in consultation with parents, awarded CAP scores to first and second ears, these were then compared. Second ear CAP scores obtained after varying lengths of CI use were analysed. Parents were asked about their children's AP usage and also about their perceived benefits of second ear implantation. **Results:** 24% of users successfully use triphasic pulses in both implants and 7% just in the second implant to manage non auditory stimulation. Recent, first and second ear implant sound field thresholds were available for 25 CI users. The mean threshold for first ears was 30 dBHL and 38 dBHL for second ears. Only one user had better access to sound with her second ear than her first ear. First and second ear thresholds for 3 users' were very similar, 22 users' second ear thresholds were worse than their first ear thresholds. Both median and mean first ear CAP scores were 7 (range 5–9). Both median and mean second ear CAP scores were 5 (range 3–9). There was a tendency for second ear CAP scores to improve with increasing use. The mean CAP score after 1 year was 4.8, after 2 years – 5.2, after 3 years – 5.5 and after 4 years – 5.7. 38 users wear both audio processors (AP) all day long and report best hearing with bilateral use. 2 users use there second ear AP less than their first and 2 users rarely use their second ear AP's. Parents report that these 2 adolescents do hear better when they wear both AP's but they do not want to be seen wearing them! 88% of parents described how their children heard softer sounds, understood more readily and were able to locate some sounds with bilateral use. Some were pleased that if a problem occurred with one ear the child had the other ear to fall back on. Some mentioned improved speech intelligibility overtime. **Conclusions:** Although performance of the second ear is often poorer than that of the first ear this study proves sequential implantation is advantageous. Availability of triphasic stimulation allowed users with loudness tolerance issues to be provided with comfortable and effective programs.

A cortical biomarker of auditory processing efficacy in children with single-sided deafness using a cochlear implant

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Background: Accumulating evidence suggests that single-sided deafness (SSD) during early development results in cortical reorganization. Children with SSD are deprived of binaural hearing and consequently exhibit reduced audibility, compromised sound localization, and difficulties in listening in noise. Additionally, current knowledge indicates speech and language impairments, slower educational progress, and aberrant socio-emotional function. Despite these detrimental effects information regarding auditory function and processing efficacy is scarce, and clinical assessment tools are underdeveloped for this unique population. The goals of the present study were to evaluate auditory function and cortical speech processing efficacy in children with SSD using a cochlear implant (CI) by means of the P1 evoked potential obtained within a clinical setting. **Methods:** Twenty-two children with SSD implanted at 4 years (mean; range 1.3–8.8), using a CI for 12 months (mean; range 6–25) participated in the study. Onset of deafness was prelingual (13), perilingual (7), or postlingual (2), with CMV as the most prevalent etiology. Cortical responses to the speech sounds /m/, /g/, and /t/ presented at 65dBSPL from a loudspeaker were recorded in 3 listening conditions: Normal hearing (NH) ear, CI+NH, CI (NH-masked) while children watched a silent movie. The prevalence, latency, and amplitude of P1 were compared among listening conditions and speech sounds. Speech perception with the CI was evaluated via direct audio input (DAI). **Results:** The overall prevalence of P1 elicited in the NH, CI+NH, and CI (NH masked) listening conditions, was 100%, 96%, and 78%, respectively. The P1 prevalence for the /m/ sound was 52% in the CI (NH-masked) condition, and was associated with CI manufacturer. P1 latencies were significantly prolonged and amplitudes were reduced in the CI (NH-masked) condition compared to the NH and CI+NH conditions. P1 latencies elicited by the /m/ sound were prolonged compared to the /t/ and /g/ sounds, but did not differ among listening conditions. Open-set, closed-set, and detection-only speech perception abilities were evident in 50%, 30% and 20% of the children, respectively. Correlations between the studied measures and

CI side, etiology, and speech perception were weak and not significant. **Conclusions:** Taken together, recording the P1 in children with SSD using a CI is feasible in a clinical setting and provided objective evidence for: 1) Cortical detection of speech sounds at a conversational level; 2) Reduced processing efficacy and synchrony with the CI compared to the NH and CI+NH conditions; and 3) Device-dependent detection of low frequency sounds (/m/). The current methodology is advantageous for evaluation of CI benefits, ongoing monitoring, and rehabilitation decision-making in young children, as behavioral testing accuracy and reliability is limited.

A long-term follow up of children receiving ECAP-based programmed CI – do they benefit from a behavioral based MAP?

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Objectives: Small children who receive cochlear implants (CI) at an early age cannot take active part in the programming of stimulation levels, i.e. setting the T- and C-levels. Therefore, objective measurements that do not require active participation of the child are commonly used along with observations of the child and how it spontaneously reacts to the sound stimulation. Electrically evoked compound action potential (ECAP) is a common objective measurement to use as a basis for programming CI. The ECAP-measurement is used to find the lowest level of electrical stimulation required to detect a response from the auditory nerve. ECAP-thresholds can in most cases be recorded from all intra-cochlear electrodes, carried out with the CI both stimulating the auditory nerve as well as recording the response. Several studies, involving adult CI users, have shown that there are weak to moderate correlations between ECAP-thresholds and behaviorally obtained T- and C-levels, and some researchers have even considered it too weak for using ECAP-thresholds as the basis for programming the implant. Anyhow, ECAP-thresholds are widely used for programming CI on small children, and from clinical experience the children seems to do well with these settings. However, to our knowledge there are no studies that have carried out a long term follow up for investigating if these children would benefit from a behaviorally based reprogramming. Our aim with this study is to investigate if it would be beneficial to re-program the CI using behaviorally obtained T- and C-levels when the children are old enough, or if they can continue to use the ECAP-based settings with no difference in hearing outcome? **Material:** About 15 children are expected to be enrolled in the study, aged between 7 to 14 years, all with CI's from Cochlear Ltd (CI24RE or newer). All children have received their implant before the age of 3 and CI's programed based on ECAP-measurements, have no cochlear malformation and have documented performance from both speech and tone audiometry in a sound field setting. **Material:** Fourteen children were enrolled in the study, aged between 7 to 14 years, all with CI's from Cochlear Ltd (CI24RE or newer). All children had received their implant before the age of 3 and CI's programed based on ECAP-measurements, have no cochlear malformation and have documented performance from both speech and tone audiometry in a sound field setting. **Methods:** This was an intervention study where re-programming of the CI was carried out by measuring T- and C-levels on 7 electrodes spread across the electrode array. Sound field measurements with warble tones and Hearing In Noise Test (HINT), as well as ECAP-measurement, was carried out before the re-programming and 4 months after the intervention. **Results:** Preliminary results will be presented. **Conclusions:** Will be presented based on preliminary results.

A review of cochlear implant users with autism spectrum disorder

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Objectives: Hearing loss and ASD can both affect an individual's communication abilities. Factors associated with ASD may have an impact on the clinical management of cochlear implant users. Literature describes that individuals with autism spectrum disorder (ASD) may be less inclined to engage with other children and adults in typical social interactions with the result that they may be less interested in typical play and social/positive reinforcement used to teach a desired behaviour. There are also documented sensory stimulation tolerance issues associated with ASD. Changes in routine have also been shown to be poorly tolerated by some individuals with ASD. For a cohort of cochlear implant (CI) users who have also been diagnosed with ASD, typical assessment techniques and mapping parameters may require modification. This study reviews the clinical practices and audiometric and speech perception results of individuals with ASD who use cochlear implants. **Material:** A retrospective review of case records and assessment results was conducted for the cohort of CI recipients with ASD from an Australian CI clinic. A range of aetiologies and ages were represented. Methods: Map information and case notes were reviewed along with formal and informal interviews with parents and teachers for some paediatric members of the group. Results from formal testing in the clinic and from observations made when visiting the children in their educational settings were also incorporated in the retrospective analysis. **Results:** The CI recipients with ASD have been observed to not always tolerate maps with typical or default current levels, program settings or dynamic ranges. Lower map levels or reduced dynamic ranges were at times required. Tactile defensive behaviour related to ASD meant that some subjects did not tolerate wearing their sound processors in the standard configuration. Behavioural therapists and/or desensitization techniques were required to reintroduce sound processor use when it was interrupted for some individuals. Standard audiological tests often produced limited results for the group. Clinical case notes recorded for the subjects describe the challenges in using standard behavioural play-based or functional testing methods. An additional clinician was often needed to assist during testing. Discussions with education professionals working with these children showed that teachers may assume that either the hearing loss or ASD in isolation is contributing to a lack of speech and language development. A child's lack of

typical responsiveness to speech directed at them may mean that teachers or others have little faith that the CI technology is working. **Conclusions:** Flexible approaches are often required when working with CI users who have ASD and will vary with how severe the autistic characteristics may be for an individual. The audiologist needs to be wary of potential for over stimulation and device rejection. Overall, a multidisciplinary team approach is needed to best support these patients and close communication with educators and other professionals can help in optimising case management.

Accelerated cognitive decline due to hearing loss and bilateral vestibulopathy: A cross-sectional study using the RBANS-H in the DFNA9 population

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Background: Deafness autosomal dominant 9 (DFNA9) is hereditary disorder known to affect both hearing and vestibular function in its carriers. Its phenotype is characterized by a progressive sensorineural hearing loss (SNHL) and vestibular dysfunction evolving towards bilateral vestibulopathy (BV) by the 3rd to 5th life decade. Recent studies have identified the impact of hearing loss and vestibular dysfunction on cognitive function. **Objective:** The main objective of this study is to investigate how cognitive functioning of carriers of the p.Pro51Ser variant in the COCH gene is affected by the disease and compare these results with a healthy matched control group. **Material and methods:** Forty-seven carriers of the pathogenic p.Pro51Ser variant in the COCH gene were included in this study, of which 38 met the Bárány Society criteria and were thus diagnosed with BV. Each control was individually matched based on age, gender and education level. A cognitive, vestibular and hearing assessment was performed in all subjects. All participants completed the Repeatable Battery for the Assessment of Neuropsychological Status, adjusted for the Hearing Impaired (RBANS-H), a cognitive screening test which includes subtests probing Immediate and Delayed Memory, Visuospatial Capabilities, Language and Attention. Hearing assessment consisted of a liminal audiometry and speech-in-noise testing (SPIN) using the Leuven Intelligibility Sentence Test (LIST). This was followed by a vestibular assessment, including video Head Impulse Test (vHIT) and electronystagmography (ENG). Mean RBANS-H scores of DFNA9 patients and controls were compared using the non-parametric Wilcoxon rank-sum test. **Results:** DFNA9 patients demonstrated significantly lower scores on all subscales (except the Language subscale) and total percentile score compared with their healthy matched controls. The total sample was divided into two groups: age <55 years old and age ≥55 years old. Cognition of DFNA9 patients aged <55 years old did no longer differed significantly from their matched controls, except for the Immediate Memory subscale. **Conclusions:** DFNA9 patients' cognition scored significantly worse when compared with their healthy matched controls, suggesting an impact of their SNHL and vestibular loss on their cognitive performances. This significant effect was not observed in the age group younger than 55 years old. Further research is needed on the individual trajectory of SNHL, vestibular function and how hearing rehabilitation affects cognitive functioning.

Accuracy of telemedicine enabled device for screening ear and hearing loss in rural and urban communities of India

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Introduction: According to World Health Organization (WHO), over 5% of the world's population comprising of 466 million people have disabling hearing loss, and by 2050, over 900 million people (1 in every 10 people) will have disabling hearing loss. The significant burden of hearing loss and limited access to ear and hearing health services in developing countries require new methods of providing access to ear and hearing health care. In 2013, an innovative ear care program, called Shruti, was launched in rural and urban areas across India to increase awareness, screening, diagnosis, and treatment for the underserved. We sought to determine the accuracy of the in-field otology and audiology assessments performed by the Shruti trained community-health workers (CHWs) using it tele-otology and tele-audiology device named "ENTraview" as compared to the diagnosis made by the ENT specialist. **Methods:** Accuracy studies were completed. A retrospective sampling study was completed to compare the agreement in screening for and diagnosing ear disease/hearing issues between the CHWs using ENTraview and the ENT specialist diagnosis. This retrospective analysis was conducted with 743 patients across 115 sites and 205 CHWs. **Results:** Shruti ENTraview device otology functionality accuracy was examined over a total of 743 patients. The most common diagnoses were CSOM in 41% of patients, wax in 30% and hearing loss in 21%. The sensitivity rate of the community health worker diagnosis was 92.0% with corresponding 95% confidence interval of 89.9–93.9%. When a patient was diagnosed with a hearing issue by the ENT specialist, the community health worker had the same diagnosis 92% of the time. **Conclusions:** The burden of ear disease and hearing loss, within communities across India, is high and barriers exist, for patients and providers, across the continuum of care, including access to early screening and diagnosis. The Shruti program created an accurate way to increase

access to screening/awareness, early diagnosis, and affordable treatment, for individuals with diagnosed ear disease as well as hearing loss, through their technology innovation and WHO guideline-based trained CHW workforce.

Active transcutaneous bone conduction implant and adhesive bone conduction devices: Follow up on audiological performance and subjective satisfaction

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Introduction: In 2014 it was implemented a bone conduction implants program at the national Chilean reference center for genetic syndromes and cranium facial malformations in children. Since then, 56 pediatric patients with agenesis of external auditory canal had been implanted with active bone conduction implants. It was already reviewed the surgical and audiological outcomes, but not the quality-of-life results. Other issue was the need to compare the audiological results with users of not implanted devises (adhesive bone conduction devises). **Objective:** To assess the audiological performance and subjective satisfaction of children implanted with active bone conduction implants and compare it with adhesive bone conduction devices results. **Method:** Prospective, multicentric study (Argentina and Chile). Performance and subjective satisfaction were evaluated at 1-, 6- and 12-months post implant activation. Tests: sound field audiometry, sound field speech in quiet, sound field speech in noise, hearing questionnaires (MUSS, MAISS, KIDSCREEN) and audio processor specific questionnaire. We compare the audiological results with a previous study in a similar group of children that implemented the same methodology. **Results:** To date we have evaluated 10 children with congenital aural atresia (6 unilateral/4 bilateral) implanted with an active bone conduction implant. Mean age: 11±2 years (range: 8–15 years). All of them completed the 1 month and 6 months evaluation and 9 out of 10 completed the 12 months evaluation. The average PTA pure tone thresholds are AC 70.3 dB; BC 14.7 dB. Sound field Audiometry with the implant is close to 20 dB for all frequencies and the results are stables on time. Speech in Quiet discrimination improved from 42% to 100%, speech in noise improved from 33% to 95% with noise at 60 dB SPL and from 25% to 89% with noise at 65 dB SPL. The total score of the audio processor specific questionnaire is 85%, score of MUSS 40, score of MAIS 39 and score of KIDSCREEN 4.4. On the other hand, the results for a similar group of children with conductive hearing loss using adhesive bone conduction devises: Sound field Audiometry close to 35dB for all frequencies, Speech in noise improved from 22% to 80% with noise at 60dB SPL. **Conclusions:** Considering these are preliminary results, they show a clear benefit of the active bone conduction implant in quality of life and hearing performance. Also, the audiological performance is better than the results with adhesive bone conduction devices. It is necessary to complete the study to confirm these data.

Additional disabilities in children with sensorineural hearing loss

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Objective: The structure of additional disabilities (AD) in children with sensorineural hearing loss (SNHL) and its impact on age of SNHL detection and amplification were investigated. **Methods:** Case histories of 321 children (153 boys, 168 girls) with SNHL, observed in St. Petersburg Center of Pediatric Audiology were analyzed. The group included 153 boys, 168 girls with age from 3 months to 18 years. 16% of children had mild; 22.4% – moderate; 14% – severe; 33.6% – profound SNHL. 14% of children had unilateral SNHL. **Results:** AD were found in 41% cases. Children had disorders of the different systems: in 46% – central nervous, 14% – motor, 9% – vision, 6% – urinary, 5% –cardiovascular, 5% – digestive, 4% – pulmonary, 3% – face-skull abnormalities, 3% – intranatal infections, 3% – disartria, 1% – endocrine pathology, and 1% – mucopolysaccharidosis and rheumatic diseases. 59% of children had 2–3 AD besides SNHL. In 41% only one AD was detected, in 39% – two and in 20% – three. The combination of central nervous system and motor disorders was the most frequent (26%). Genetic etiology (on the base of genetic analysis and family form of SNHL) in children with AD observed significantly less often (11.6%), than in group with SNHL only (39%) ($p<0.001$). The correlation between the presence of AD and SNHL degree in this cohort was insignificant ($p>0.05$). The gender differences in the prevalence of AD hadn't been found as well ($p>0.05$). Mean age of detection of SNHL was slightly higher in children with AD (49.9 months) than in children with SNHL only (47 months) ($p>0.05$). But early hearing loss detection (before 4 months) was significantly ($p<0.001$) lower in children with AD (6.8%) than in children without AD (31.7%). 65.6% of children used hearing aids or cochlear implants, 36.4% of children didn't use hearing devices. In the most cases non-users were children with unilateral or mild bilateral SNHL. Some children didn' use hearing aids because of parents' rejection, as a rule, the deaf parents. Intergroup differences between a number of hearing aids and cochlear implants users were insignificant ($p>0.05$). However, the gap between SNHL diagnosis and initial amplification in children with AD was 10 months longer comparing with the children with isolated SNHL ($p>0.05$). **Conclusions:** The late detection of SNHL in children with AD in comparison with children with isolated SNHL could be explained because of many children with AD get treatment at intensive therapy units in the first months of life, where the newborn hearing screening could be missed in some cases. Moreover, the treatment of somatic pathology is more actual for the pediatricians and parents during first two years of life, and speech and hearing delay could be explained by neurological pathology or brain immaturity. The possibility of late development of hearing loss due to the treatment of AD also can't be excluded. The children with SNHL and AD have the equal opportunities for amplification as children with isolated SNHL in Russia. But choosing of type of hearing device and its fitting takes more time for children with SNHL and AD.

An interpretation of fine structure of transient evoked otoacoustic emissions

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Objectives: We can expect that during the amplification of traveling wave produced by click stimulus each outer hair cell (OHC) produces some additional acoustic activity, and this activity reaches the ear canal. The reasonable assumption is that this activity is similar in shape for all OHC, but differs both in time scale and latency. It can be shown that for homogeneous cochlea almost all components of this activity are mutually suppressed, but each irregularity or lack of OHC will produce uncompensated response. Therefore, we can expect that transient evoked otoacoustic emission (TEOAE) should have components similar in shape but with duration almost proportional to latency. **Material and methods:** For verification of this hypothesis TEOAE data obtained in response to click stimulation were collected from 5 normally hearing volunteers using ILO probe, professional sound card and preamplifier of custom design. The data were averaged off-line using weighted averaging in time and frequency cells. Then the dominant components not corresponded to this hypothesis were removed and the blind deconvolution was applied to the rest of signal. For calculation of the exact relationship between time scale and latency of components the appropriate optimization was applied. All algorithms were carefully optimized and tested on a large set of modeled data and on a data obtained without stimulation. It was approved that the algorithm didn't produce false components, but the modeled components of different shapes were detected without disturbance. **Results:** For all records the algorithm produces a pattern like a tone burst with almost constant amplitude, sharp cut-off and a splash on first periods. **Conclusions:** It was shown that at least a part of TEOAE signal can be explained by proposed hypothesis. We digitally simulated a wide hole in rows of OHC. It was found that the maximal amplitude of uncompensated response is only 50 times greater for wide hole than for a lack of single OHC and the amplitude decreases for wider damages. Therefore, serious impairments shouldn't produce significant responses on its bounds. The shape of activity can also give some explanation for the effect of spectral periodicity of TEOAE demonstrated by George Zweig and Christopher Shera.

Analysis of pathogenic potential of intronic variants in the ATP2B2, MYO6 and MYO15A genes related with hearing loss using a „minigene" model

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Introduction: With fast development in molecular biology, next-generation sequencing (NGS) became more accessible and less costly as a diagnostic tool, invaluable especially in diagnosing such heterogenic disorders as hearing loss. Vastness of data generated by this method allows speedy diagnosis but also creates a need for experimental verification of identified variants pathogenicity. Many of synonymous and intronic variants were thought of as having no impact on coded protein and as such as not pathogenic. Now it is known that they might influence transcript splicing. The goal of this study was to assess pathogenicity of 4 intronic variants in ATP2B2 (c.941-7C>G), MYO6 (c.1984-1G>A, c.2508-1G>A) and MYO15A (c.6178-1G>A) genes by using a "minigene" approach. The variants were identified in hearing loss patients from the Institute of Physiology and Pathology of Hearing.. In silico analysis predicted their impact on transcript splicing. **Objective:** Assessing influence on transcript splicing using a „minigene" model for variants identified in ATP2B2, MYO6 and MYO15A genes. **Material:** Genomic DNA used in this study was isolated from blood samples. Informed consent form was provided. Used plasmid vectors were pDONR221 (Thermo Scientific), pCS2+ and pDEST pCI-NEO RHO. **Methods:** In silico analysis of variants impact on transcript splicing was performed using NNSplice, MaxEntScan and SpliceSiteFinder. Sequences spanning one exon upstream and one exon downstream of the analyzed variant was cloned into pCS2+ expression vector or in case of ATP2B2 into pDEST pCI-NEO RHO using the Gateway cloning system. Expression vectors with wild type sequences underwent mutagenesis reactions, introducing the studied variants. NIH/3T3 and HEK-293 cells were transfected with both wild type and mutant vectors and harvested after 48h. RNA was isolated and used in RT-PCR reaction. Sanger sequencing of the reaction products was performed. **Results:** The c.1984-1G>A variant in MYO6 shortened the transcript by 1 bp in exon 20, as predicted in silico. The MYO6 c.2508-1G>A variant shortened exon 25 by 144 bp, more than bioinformatically predicted (19 bp). The MYO15A variant c.6178-1G>A led to the expected shortening of exon 29 by 1 bp and to skipping of exon 29 by deleting its acceptor site. The c.941-7C>G variant did not influence ATP2B2 transcript splicing, despite bioinformatic predictions. **Conclusions:** Variants in MYO6 and MYO15A could be classified as potentially pathogenic as they change transcript splicing and it is a known mechanism of pathogenicity in these genes. The c.941-7C>G variant in ATP2B2 could be classified as likely benign, since it does not affect transcript splicing. Gateway cloning system turned out to be a quick and easy alternative to cloning using restriction enzymes.

Anatomy based fitting: A new fitting method for every cochlear implant user?

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Introduction: Significant variability exists in angular insertion depth both across and within cochlear implant arrays. Mapping procedures use cochlear tonotopicity by assigning low- to high-frequency information across apical to basal electrodes but do not individualize frequency allocation using the exact location of electrode contacts. Anatomy-based fitting is a new fitting method that allows personalization. The prerequisite is new fitting software, in which patient-specific data can be imported from a planning platform for otological surgery. It is then possible to calculate and display each individual electrode contact's tonotopic frequency. The audiologist can then set a frequency-band distribution that is more closely aligned to the tonotopic frequency distribution. The aim of this study was to 1) compare the benefit of a new fitting methodology with the established fitting methodology and 2) evaluate other influencing factors, e.g., insertion depth and electrode array. **Methods:** Participants are adults who are experienced unilateral or bilateral adult cochlear implant users. In each individual, the angular insertion depth of the electrode array and the electrode contacts were calculated. The frequency filters in the audio processor were re-calculated and shifted to match the "better hearing" side e.g., in single-sided deafness the normal hearing ear; in bilateral users the better hearing side. Speech perception in noise (in different spatial settings), pitch and timbre perception in musical instruments and speech, and patient-reported outcomes were assessed at two intervals. At study start, subjects used their routine clinical map (with standard frequency bands). Subjects were then fit with an anatomy-based fit map. After three months of use with this map, subjects repeated the tests. **Results:** Preliminary results are that bilateral users with different electrode array lengths had better overall sound quality and a higher acceptance rate with the anatomy-based fitted map than they did with their routine fitting. Using the anatomy-based fitted map may improve experienced bilateral user's speech understanding in noise, but it also might decrease speech understanding in their weaker side. All unilateral patients that were implanted with a standard length electrode array preferred the anatomy-based fitting, as shown by improved speech perception in noise and better sound quality. **Conclusions:** Initial acceptance of anatomy-based fitting in experienced users is dependent on the electrode array length and insertion angle. Anatomy-based fitting should be considered as an alternative to the standard clinical fitting in dissatisfied cochlear implant users.

Application of Vibrant Soundbridge in hearing restoration after modified radical mastoidectomies in children

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Introduction: Fundamental aim of the radical surgery is to remove the focus of infection from the middle ear area and to ensure patient's safety. An important principle of various modifications of those operations is to leave in place even the smallest remains of conductive apparatus of the middle ear in such a way that they do not become the source or cause of disease's recurrence while enabling effective reconstruction in future. But sometimes reconstructive surgery is impossible or ineffective. In such cases we can help the patients with middle ear implants e.g.. Vibrant Soundbridge (VSB). **Aim:** The aim of this paper is the retrospective analysis of the results of VSB implantation in ears after modified radical mastoidectomies in children. **Material and methods:** The analysis was performed in a group of 31 children; observation period was minimum 1 year. The results were assessed in about 1 month, 3 months, 6 months and 1 year in accordance with the follow-up program adopted in our Institute. Surgical procedure included implantation of VSB with direct stimulation of Round Window (RW) membrane with Floating Mass Transducer (FMT). **Results:** Observed results confirm that, even in cases of very advanced, chronic otitis media with cholesteatoma, temporal bone destruction or granulation, or with all changes together, in cases where tympanoplasty is impossible or has no good results we have possibility of hearing restoration with VSB implantation. **Conclusions:** 1. Patients after radical mastoidectomy without possibility of tympanoplastic surgery can be candidates to VSB implantation. 2. The obtaining of very good hearing results in our group of patients with direct RW membrane stimulation with FMT transducer of VSB, ought to be considered as the valid proposition of management of choice in such cases.

Applying the Person-Environment-Occupation Model to explore the participation of employees who are d/Deaf at an institution of higher learning

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Background: Work participation is key to economic independency, professional and social fulfilment, and personal identity. However, participation is not always seamless for individuals with disabilities such as deafness. In the workplace, employees who are d/Deaf are treated differently from their hearing counterparts. **Objective:** To explore participation and communication experiences of employees who are d/Deaf in the workplace. Specifically, this study aimed to utilise the P-E-O model to understand the participation and communication experiences of employees who are d/Deaf at a university. **Methods:** Thirteen participants were recruited through purposive sampling, were interviewed using semi-structured, open-ended interviews, which took approximately 30–45 minutes per participant. Thematic analysis was applied to identify and describe patterns in this qualitative study. Specifically, the person-environment-occupation was applied in the analysis of the findings. **Results:** The findings of this study indicate that people who are d/Deaf experience participation and communication difficulties in the workplace. Primarily, communication experiences were discussed in terms of exclusion and isolation; lack of interpreting services; job satisfaction as well as lack of support. At the core of the communication problems lies the fact that in general, very few hearing people use sign language to communicate. **Conclusions:** The use of the P-E-O sheds light on the

communication challenges faced by workers who are d/Deaf in the workplace. The model can highlight the importance of the environment to create a fit among workers in the workplace. Also, the this model demonstrates how the person and the environment influence participation and promote congruency across the P-E-O elements.

Assessment of the effectiveness of the use of directional microphones in Sonnet 2 processors in children, users of cochlear implant systems

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Introduction: The Sonnet 2 processor allows the cochlear implant user to use omnidirectional microphones as well as directional microphones with different directivity characteristics. So far, the benefits of using the new method of shaping the microphone characteristics in Sonnet 2 processors in children have not been demonstrated. **Objective:** To evaluate the benefits of using a directional microphone with directivity characteristics similar to those of the pinna. **Material and methods:** 36 children aged from 7 to 18 years (mean age: 10 years; SD 2.13) were included in the study. The tests were carried out during the replacement of the Opus 2 sound processor with Sonnet 2. The Adaptive Auditory Speech Test (AAST) was used to assess the effectiveness of directional microphones. The test was carried out in an audiometric cabin, the speech signal was presented in front of the patient (azimuth 0), the noise was presented on the back (azimuth 180). The test was performed in three configurations: in the Opus 2 processor (omnidirectional microphone), in the Sonnet 2 processor with an omnidirectional microphone and in the Sonnet 2 processor with a microphone with characteristics similar to the characteristics of the pinna ("Natural" in microphone settings). **Results:** The analysis of the obtained results showed no significant differences between the speech recognition threshold in the Opus 2 processor and Sonnet 2 processor with an omnidirectional microphone. The results obtained with the Sonnet 2 processor with a microphone similar to the characteristics of the human ear (Natural) were significantly better than both the results obtained with the Opus 2 processor and the results obtained with the Sonnet 2 processor with an omnidirectional microphone. **Conclusions:** The use of new technology in the form of microphones with characteristics similar to the characteristics of the pinna significantly increases the hearing benefits of impl0anted children.

Assessment of wideband middle ear absorbance in implanted partial deafness (PDT) patients

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Introduction: Wideband -ear energy absorbance (EA) is an objective measure for assessment of middle ear conduction properties. The effects of cochlear implant surgery and the presence of implant electrode may influence middle-ear immittance thus affecting energy transmission and absorbance. Till present, this problem has not been fully investigated in PDT patients. Objectives: „The aim was to assess the influence of implant electrode, inserted through round window with application of minimal-invasive Skarzynski six-step PDT procedure, on acoustic properties of the middle ear. It was intended to find if there exist absorbance abnormalities that may indicate detrimental changes in the middle characteristics. **Material and methods:** Energy absorbance (EA) was measured, with other immittance-related characteristics, in a group of PDT patients in pre- and postoperative period. The results were compared against a control group of similar age and gender with no middle ear pathologies. Titan Interacoustics WBT system was used for absorbance measurements. Standard clinical instrumentation and methods were used in other audiologic tests. **Results:** The results show that surgery effects and the presence of implant electrode cause only minimal changes to middle-ear energy absorbance. Frequency EA characteristics remain, in most cases, within the area of normal ear absorbance. No significant differences were observed between the PDT implanted group and the control group. Either, there weren't significant differences between the characteristics of implanted and contralateral ear, neither between EA in pre- and postoperative period. Conclusions: Preliminary results indicate that implant electrode in the ear implanted with low-invasive, window approach method has little influence on middle ear wide-band absorbance, which may indicate that transmission properties of the middle ear remain unchanged.

Atresia or stenosis of the external auditory canals with normal auricles in children

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Objectives: Congenital malformations of the external auditory canal (EAC) – stenosis or atresia, as a rule, correlate with the degree of underdevelopment of the auricle. However, in some cases, the patient may have congenital stenosis or atresia of the EAC with normal or slightly hypoplastic auricles. Late diagnosis of such anomaly in the case of bilateral lesions leads to delay in the child's speech development. **Aims**: To analyze the structure of pathology and the reasons of late diagnosis. **Material:** From 2011 to 2022, we observed 27 children (11 boys and 16 girls), who had bilateral atresia or stenosis of the EAC with normal or slightly hypoplastic auricles. **Methods:** All children underwent a hearing examination – PTA, ABR, CT of the temporal bones. The state of hearing was observed in dynamics. **Results:** 21 children had normal auricles, 2 – mild hypoplasia, 4 – slightly dysplastic auricles of normal size. Severe stenosis along the entire length of the cartilaginous and bony parts of the EAC, which does not allow seeing the tympanic membrane, was observed in 3 children with an abnormal skull bones conditions (Cruson, Pfeiffer and Goltz-Gorlin syndromes). In the remaining 24 children, stenosis of the cartilaginous part of the EAC, turning into atresia of the bone part was observed in 13 children, atresia of the both parts of the EAC in 11 children. In this

group of children, CT of the temporal bones revealed dysplasia of the auditory ossicle chain and its fixation to the zone of atresia, without an obvious decrease in the size of the tympanic cavity and anomalies of the auditory tube. Inner ear anomalies were not observed in any child. 8 children had a 18q- syndrome, 1 child had a mosaic variant of Edwards syndrome (trisomy for 18 pairs of chromosomes). The parents of the remaining 15 children did not turn to genetics, while the mother of one child had a similar ear anomaly, 1 girl was twins, and 1 child had several malformations of other organs. Of the 27 children, hearing screening in the maternity hospital was carried out for 4 children, of which 3 children had result "REFER". In these children, the pathology was detected timely, hearing and speech rehabilitation was successful. In the remaining 24 children, the mean age at the time of diagnosis was 4 years 3 months. All children had moderately-severe conductive hearing loss, 1 child with 18q-syndrome had a progressive mixed-type hearing loss. Primary hearing aid fitting was performed with bone conduction hearing aids on a soft band. Further, depending on a number of factors (CT of the temporal bones data, state of intelligence, the wishes of the parents), a decision was made to switch to wearing bone conduction hearing aids on a fixator or to perform meatotympanoplasty. Behind-the-ear hearing aids fitting were performed in 3 children who had controlled stenosis of the cartilaginous part of the EAC and complete atresia of the bone section. In the presence of filiform EAC, behind-the-ear hearing aids was avoided so as not to provoke the development of EAC cholesteatoma. **Conclusions:** 1. The reasons for the late diagnosis of this pathology are: the ineffectiveness of newborns audiological screening due to the lack of systemic control, careless otoscopy and the fact that this pathology is unknown to a wide range of otorhinolaryngologists. 2. Atresia of the EAC in normal auricles is often caused by anomalies of 18 pair of chromosomes, and severe stenosis of the EAC can be observed in children with craniostenosis and others skull bones anomalies.

Attenuation of the input signal by protective and fixing tools for hearing aids and cochlear implants

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Introduction: Hearing aids and cochlear implants are effective rehabilitation methods for hearing impaired patients. It's necessary to protect a microphone from humidity, cold and wind. For this purpose, different clothes and protective tools are used. The aim was to study amount of attenuation of input signal at the hearing aid (HA) or cochlear implant sound processor (SP) microphone by different protective tools or clothes. **Material and methods:** The acoustic measurements were conducted in the soundproof cabin using artificial head with HA/SP and different protective tools, which can influence on microphone function. Sequential measurements were conducted in following conditions: 1) SP without any protective tools; 2) with protective case (No 1,2,3); 3) with water-resistant case for swimming; 4) SP fixed on the head using elastic bandage; 5) SP covered with a hood; 6) SP covered with a double-layer knit cap; 7) SP covered with a silk shawl in two layers. Probe microphone was integrated in the microphone input of SP and connected with HA verification system. **Results:** The most significant attenuation was observed in the water-resistant case for swimming. The changes were detected at the most 1/3 octave frequency bands (12 out of 17). The most of them are located at the speech spectrum, which can lead to a significant decrease of speech audibility, intelligibility and quality. Maximum attenuation by water-resistant case is 9.36±0.33 dB at 4000 Hz. The usage of membrane tissue protective cases helps to avoid penetration of sweat, humidity into HA or SP, as well as protects them from a wind noise, showed that they give 7.67±0.18 dB attenuation at 5000 Hz. The most amount of attenuation was demonstrated with a membrane case, which has maximum sweat protection. In contrast, a textile case demonstrated less attenuation. Fixing bandage influences on sound pressure level as well, especially at middle-high frequency region. Different types of head covering clothes lead to a significant signal changing up to 9.24±0.16 dB, primarily on high frequencies, which less influence on speech intelligibility. **Results:** The results of the study confirm that using different tools to protect HA of SP leads to a significant change of input signal. **Conclusions:** The acoustic input signal measurements, presented in this paper, could be used in the certification process of new protective tools for HA and SP, which might allow to control their quality and effects. Audiologists also should use real-ear measurements with protective cases during HA verification process in their clinical practice. The information about signal attenuation must be taken into account during HA fitting to make this case acoustically transparent.

Audiological adverse effects and ototoxicity of drugs used in the treatment of SARS-CoV-2 – perspective 2021 and 2022

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Background: Although the COVID-19 outbreak occurred in December 2019, when cases of the unknown disease were made public, for the next 2020, an ongoing pandemic was the cause of one of the biggest public health crises. The purpose of this article is to review current and approved pharmacological treatments and highlight the potential ototoxic side-effects. **Methods:** Review of the available literature in the scientific databases: PubMed, ResearchGate, Scopus, and ScienceDirect. **Results:** Treatment with new therapeutic unit often begins with its use outside the primary indication the so-called off-label. Adverse events may be permanent or disappear over time. Ototoxicity and audiological side effects can directly cause hearing damage or vestibulocochlear disturbances, as well as be an indirect effect. **Conclusions:** The most frequently adverse reactions reported in clinical trials after pharmacotherapy of

COVID-19 in the area of audiology and otorhinolaryngology were: dizziness, blurry vision with dizziness, nasopharyngitis, dysgeusia, tinnitus. As far as vaccines are considered, dizziness as an ototoxic effect may occur only in hypersensitive people as apart of anaphylactic shock and as adverse re action with uncommon frequency. In 2021 there were no report about new, different adverse reaction in the field of audiology and otorhinolaryngology. The presented methods of audiological tests allow for very quick determination of drug ototoxicity and can be used in the diagnosis of patients.

Audiological and histopathological effects of propolis on noise-induced hearing loss

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Introduction: Noise causes mechanical and metabolic damage to the inner ear (cochlea) and causes noise-induced hearing loss (NIHL). Current research indicates that decreased blood flow to noise-induced coccycitis and increased free radicals play a role in the development of hearing loss. The increase in free radicals indicates that the cells in the cortical organ are exposed to necrosis and apoptosis. In pharmacological applications, especially antioxidants are used to struggle free radical growth and oxidative stress in the cochlea. In this context, there is no antioxidant in the literature that is highly efficient or commonly accepted. The aim of this research is to investigate the audiological and histopathological effect of propolis, which is known for its antioxidant properties, against NIHL. **Material and methods:** Thirty male adult albino wistar rats were divided into five groups as n=6. Distortion Product Otoacoustic Emission (DP-OAE at 842–7996 Hz) was performed to all rats to learn about their hearing. OAE measurements with a signal/noise ratio above 3 dB at 2f1-f2 frequency were accepted positive (normal) during measurement. Only saline (SF) was given to the first group as control group. 2 groups received 1 dose ×7 days of dimethylsulfoxide (DMSO) and 3 groups received 1 dose ×7 days of propolis extract intraperitoneally (IP). The 4th and 5th groups were given 120 dB SPL and 4 hours of noise at 4 kHz on the first day. 4th group received DMSO, group 5 received Propolis extract 1 dose ×7 days in IP. For hearing thresholds, auditory evoked brainstem potentials (AEBP) at 8, 12, 16 kHz were administered on days 1 and 7 after noise. After the last AEBP test, rats' cochleas were removed and sacrificed. **Results:** As a result of binary comparisons. The threshold values of the Propolis + Noise (p1: 0.005; p2: 0.004; p3: 0.004; p<0.05) and DMSO+ Noise (p1: 0.030; p2: 0.019; p3: 0.048; p<0.05) groups on the first day were significantly higher than the Control, DMSO and Propolis groups. The first day threshold values of the propolis + Noise group were significantly higher than the Control, DMSO and Propolis groups (p1: 0.005; p2: 0.004; p3: 0.004; p<0.05). There was no statistically significant difference between the other groups on the first day and 7th day (p>0.05). Propolis+ Noise group 1. Day and 7. A significant difference was observed in 8 kHz when compared to day thresholds. No significant difference was found at 12 and 16 kHz, but improvements were found in wave morphologies and threshold values. According to histopathological findings, control, DMSO and Propolis groups were normal observed in histological structure. In the DMSO + Noise group, hertopathological changes in the epithelial and subepithelial connective tissue in the corti organ and stria vascularity were observed. It has been reported that spiral ganglia could not be selected in the DMSO + Noise group. In the Propolis + Noise group; it has been stated that the histopathological structure is better preserved than the DMSO + Noise group and that there are images similar to the control, DMSO and Propolis group. **Conclusions:** When propolis is used by creating extracts with DMSO in NIHL, improvement in threshold values and improvement in wave morphology were achieved according to AEBP evaluation. In addition, it was observed that the structure of stria vascularity with propolis extract was preserved in histopathological examinations.

Audiological outcomes and quality of life assessment in cochlear reimplant users

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The aim of present study was to determine the complication rate among cochlear implant users and to investigate audiological outcomes and quality of life after the explantation and reimplantation procedures. The retrospective study of 532 patients was carried out in the State Scientific Clinical Center of Otorhinolaryngology, Moscow, Russia. All patients underwent cochlear implantation between 1 January 2006 and 31 December 2013. Twenty-two cases required reimplantations due to several causes. The patients' data was sorted by age, cause for reimplantation, and duration of implant use, surgical findings, audiological outcomes and results of quality of life. All patients underwent audiological evaluation, device integrity testing and high-resolution CTscans of the temporal bones before the revision surgery. Speech perception performance and quality of life assessment were measured by using several closed and open set tests, as well as questionnaires: 36 Item Short Form Health Survey (SF-36), Cochlear Implant Function Index (CIFI) and Infants-Toddlers Meaningful Auditory Integration Scale (IT-MAIS) according to the patient's age and cognitive and linguistic levels. The study was conducted in 2 stages: before the explantation surgery during the initial period of speech rehabilitation and 3 months after the reimplantation. Cochlear implantation is a relatively safe procedure. However, complications can occur. Current study describes surgical and audiological findings of 532 patients after unilateral cochlear implantation. The study includes 51 (9.6%) adult patients and 481 (90.4%) children younger than 18 years old at the time of implantation. There were 245 males and 287 females in the study. Twenty-two patients (4.1%) were performed explantation due to several complications. Post-revision audiological benefit was unchanged or improved compared to the initial implantation values in all reimplanted patients. Only 5 of 22 patients (22.7%) were able to assess quality of life themselves because of age and cognitive level. There were decreases in some domains compared to the initial values according to findings from SF-36: role physical, role emotional functioning and social functioning. For example, descents of role physical and emotional functioning were registered in 3 of 5 cases (60%). As for results of social functioning there was decrease in 80% (4 of 5 cases). The questionnaire CIFI showed decreases in some levels of function in comparison with the initial results: assessment hearing function in social groups and in work environments. Hence, our study showed that the device failure is the

most common cause for the revision surgery among cochlear implant users. It greatly affects patients' quality of life that's why it is crucial to improve device technologies.

Auditory brainstem responses (ABRs) and suprathreshold tests in people with Sleep Apnea Syndrome

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Introduction: Sleep Apnea Syndrome, an extreme form of Sleep Breathing Disorders, is a common cause of cardiovascular disease, and consequently, usually leads to other multiorgan diseases, including the organs of the sense. Many years of deep blood desaturation processes, as a consequence of prolonged sleep apnea, also affect the hearing organ – directly and indirectly through the disorder of other organs. **Purpose:** The results of tonal and impedance audiometry of people with Sleep Apnea Syndrome in the vast majority of cases fall within the age. To assess the discreet dysfunction of the hearing organ, resulting from years of blood desaturation processes, the most appropriate are tests that assess adaptation and hearing fatigue and central guidance of the brain stem. The aim of the work was to discuss the results of the tone decay test and SISI tests) and ABR in people with apnea during sleep. **Material and methods:** Studies were conducted in people aged 38 to 70 years with moderate to severe levels of Sleep Breathing Disorders (AHI from 20 to 75) and with a BMI body mass index of 23 to 52 and with an average blood desaturation rate of 8% to more than 35%. In addition tonal and impedance audiometry, patients had tone decay test and SISI and ABR overtime tests performed using click stimulus and short tones with short stimulus (2-0-2, ABR TON-2). **Results and conclusions:** In people with Sleep Syndrome with Breathless, we found bilateral incorrect values of adaptive and fatigue tests and to varying degrees of bilaterally disturbed synchronization of the fibers of the neuron VIII nerve. The Tone Decay Test ranged from 15 dB SL to 35 dB SL. ABR tests, for click and ABR TON-2, showed varying degrees of symmetrical extension of central conduction (more lengthened by the III–V interval) or it was not possible to clearly identify waves I and III with prolonged wave latens V. Volume alignment symptom (SISI 60–100%) decreased the extension of the I–V interval – to varying degrees unilaterally or bilaterally depending on the hearing threshold and participation of the cochlear component in the receiving pathology of the tested ear. These results indicate the effect of Sleep Apnea Syndrome with the receiving pathology of the type of neuritic hearing organ.

Auditory evoked brain stem responses for bone conduction using the ADHEAR bone conduction system

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Objective: The detection of auditory evoked brainstem responses (ABR), elicited via bone conduction, is a valuable objective tool for the assessment of hearing function in patients with conductive or mixed hearing loss. One of the most common challenges when applying this method in children is to provide stable stimulation conditions with constant stimulation levels throughout the diagnostic session. In the clinical routine application, bone conduction transducers, which require a certain amount of pressure on the skull, are used for adequate transmission of the stimuli to the bone. Recently the ADHEAR bone conduction system became available which transmits sound waves onto the bone via an adhesive adapter placed on the skin behind the ear without applying pressure. This pilot study aims at testing the ADHEAR bone conduction device as a transducer for bone conduction in ABR diagnostics in a group of normal hearing volunteers. **Material:** ABR testing with a clinical instrument using the ADHEAR bone conduction system as transducer in comparison to bone vibrator B81. Broadband CE chirps as well as frequency specific chirps of 1 kHz were used as stimuli. **Methods:** In a pilot study ABR tests for bone conduction were performed in a group of 10 normal hearing volunteers using broadband CE chirps and low frequency chirps fed into the external input of the ADHEAR system. Brainstem responses recorded for this testing condition were compared to tests with a standard bone conduction vibrator B81 and with responses observed for air conduction using insert phones. ABR threshold levels were evaluated separately for both stimulation devices. In addition, individual subjective hearing thresholds for the specific stimuli were determined**. Results:** For both bone conduction transducers, ABR responses could be detected. First results with the ADHEAR system showed ABR thresholds for broadband CE-chirps at about 10 dB above the individual subjective hearing threshold levels. Response patterns observed with the ADHEAR were less clear and more challenging to evaluate as when using the B81 transducer. For the 1000 Hz narrowband chirp stimuli generally the evaluation of responses appeared more challenging. The individuals tested reported less discomfort during the test for the ADHEAR system as for the B81. **Conclusions:** The ADHEAR bone conduction system appears as a useful alternative bone conduction stimulator in ABR diagnostics for bone conduction which may be particularly promising for testing bone conduction ABR in children.

Auditory Manifestations in children living with HIV at a State Hospital in South Africa

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Objective: The overall aim of this study was to estimate the prevalence of auditory pathology as well as identify factors associated with presenting with ear disease and hearing loss (HL) in children living with HIV/AIDS (CLWHA). **Methods:** This was a descriptive cross-sectional survey where CLWHA underwent an otoscopic examination and pure tone audiometric evaluations. Descriptive statistics in the form of percentages and frequencies were generated for categorical values to estimate the prevalence of auditory pathology. In addition, multivariate logistic regression was used to identify factors associated with ear disease and/or HL amongst the participants**. Results:** A total of forty-one participants aged 3–12-years-old

(22 males and 19 females) took part in this study. Twenty participants (48.7%) presented with otological pathologies which included otitis media (*n*=9, 22%), cerumen impaction (*n*=10, 23%), and tympanic membrane perforation (*n*=1, 2.4%). Auditory pathologies observed included HL, which was observed in 13 participants (32%). Lower CD4 count, longer duration of HIV infection, shorter duration on ART treatment, and concomitant tuberculosis (TB) infection were (p<.05) all associated with ear diseases. **Conclusions:** A high prevalence of auditory pathology was found in CLWHA in this study, which indicated the need for ear and hearing screening to be incorporated into 3-monthly consultations with all CLWHA; to enable early detection and intervention and thus prevent the associated negative impacts. Additionally, a multidisciplinary team approach to the management of CLWHA, specifically the inclusion of audiologists, to identify and manage auditory pathologies and the use of mHealth for early detection in resource-constrained settings is highly recommended.

Auditory processing in normally hearing individuals with and without tinnitus: Assessment with four psychoacoustic tests

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Introduction: Tinnitus is the perception of a sound without any external source. In many cases, tinnitus co-exists with hearing loss, in which case a level of poorer speech understanding might be considered to be the result of the brain having to deal with diminished sensory input. However, normally hearing subjects with tinnitus often complain of difficulty in understanding speech, especially when there is a background noise, and they sometimes blame their tinnitus for the difficulty. Central auditory processing disorder (C) APD is the name given to difficulties in the perceptual processing of auditory information in the central nervous system where typically patients have normal auditory threshold sensitivity but difficulty identifying speech in background noise. We hypothesized that auditory processing could be affected in subjects with tinnitus, which may in turn affect speech perception. **Aim:** The purpose of the study was to evaluate the auditory processing abilities of normally hearing subjects with and without tinnitus. **Method:** 54 normal hearing (mean age 37.1 years, *SD*=10.7) adults with chronic tinnitus for 3.8 (*SD*=2.5) years and 43 no tinnitus hearing (mean age 35.5 years, *SD*=11.1) subjects (the control group) were included into the study. The audiological assessment comprised pure-tone audiometry and high-frequency pure-tone audiometry, impedance audiometry, and distortion product otoacoustic emission assessment. To evaluate possible auditory processing deficits, the Frequency Pattern Test (FPT), Duration Pattern Test (DPT), Dichotic Listening Test (DLT), and Gap Detection Threshold (GDT) tests were performed. **Results:** The tinnitus subjects had significantly lower scores than the controls in the Gap Detection Threshold test (p<0.01) and in the Dichotic Listening Test (p<0.001), but only for the right ear. The results for both groups were similar in the temporal ordering tests (FPT and DPT). Right-ear advantage (REA) was found for the controls, but not for the tinnitus subjects. **Conclusions:** In normally hearing patients, the presence of tinnitus may be accompanied with auditory processing difficulties.

Auditory symptoms in taxi drivers exposed to traffic noise in Johannesburg, South Africa

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Background: Reportedly, noise is the third leading dangerous pollutant in low and middle-income countries and road traffic is the leading cause of urban noise. Owing to industrialization, there is a growing number of vehicles on urban road networks. Occupationally and environmentally, taxi drivers are exposed to noise with implications for their wellbeing and quality of life. These drivers are exposed to many physical and physiological stresses such as environmental noise, vibration, temperature fluctuations, ergonomic problems and safety risks such as accidents. As such, the presence of a hearing has more severe consequences for drivers exposed to excessive noise. However, there is a dearth of studies on the audiological symptoms that taxi drivers present with due to traffic noise. **Aim:** To describe audiological symptoms that taxi drivers who are exposed to traffic noise are exposed to. **Methods:** A cross-sectional quantitative research design was conducted with 86 taxi drivers who were recruited through purposive sampling. A self-developed questionnaire consisting of open and close-ended questions was used to collect data. Data were analysed quantitatively. **Results:** Participants reported tinnitus, blocked ears and hearing difficulties as auditory symptoms they experienced the most. 64% complained of tinnitus. All 64% of participants who presented with tinnitus stated that they are bothered by their tinnitus, which is reportedly worse at night. Tinnitus was described as a low frequency hissing sound. Furthermore, the participants reported using traditional methods of healing to cure tinnitus and were unaware of the role of an audiologist and their scope of practice in the management of tinnitus. **Conclusions:** tinnitus is one of the symptoms associated with noise-induced hearing loss. The fact that most of the participants mentioned suffering and being bothered by tinnitus highlights the need for taxi drivers to have their hearing assessed on a regular basis. Furthermore, there's a need for audiologists to raise awareness as participants, in attempting to alleviate tinnitus, are utilising methods that may cause more harm to their hearing health. Therefore, this study has implications for audiologists and their role in raising awareness of hearing health care in people exposed to traffic noise.

BAHA in various acquired and congenital ear malformations in children

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Introduction: Treatment and rehabilitation of children with conductive and mixed hearing loss in cases of congenital ear malforamtions (bilateral microtia with external auditory canal atresia), after chronic otitis media, or in single sided deafness

(SSD) can be conducted applying Bone Anchored Hearing Aids (BAHA). **Aim:** Our aim was to assess the results of application of BAHA in children and to compare hearing obtained with typical bone conduction hearing aids (head-band hearing aid, bone conduction glasses, or cross system in SSD) to hearing in BAHA system. **Material and methods:** Our method of choice in treatment of hearing impairments in presented cases of various defects of the ear was attachment of titanium fixture to the temporal bone, with or without removal of subcutaneous tissue around attachment. The procedure was performed as a one stage in older children or two-stage in younger children. After implantation the titanium screw was not used for about 6 weeks to 4 months, to provide good healing and proper osseointegration. Then a hearing aid was selected. Audiological examinations were performed 1 and 6 months after hearing aid fitting. Our material consists of 125 patients in the age form 3 y.o. to 18 y.o. **Results:** Audiological results are good and sustainable. Thresholds measured in the free field audiometry wearing BAHA hearing aids are on average 8.8 dB lower in comparison to previously used hearing aids. Our patients emphasize that the new hearing aids provide better sound quality, speech understanding, are comfortable and are more aesthetic comparing to typical bone conduction hearing aids. **Conclusions:** Application of BAHA in children with various hearing loss in ear malformations is good from audiological perspective as well as with regard to safety and everyday comfort of a user.

Bilateral Sudden Sensorineural Hearing Loss – a study of four cases

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Objectives: Presentation of the complexity of the problem of Bilateral Sudden Sensorineural Hearing Loss, symptom-related problems, treatment and prognosis. **Material:** Four adult patients with bilateral sudden sensorineural hearing loss were enrolled to the study between 2015 and 2020. Material was collected on the basis of the history of the disease from examination of medical records. **Methods:** Inclusion criteria were: bilateral hearing loss of sudden onset, age below 18 years, hearing loss of at least 30 dB at three consecutive frequencies, no recognized alternative diagnosis such as tumor. All patients underwent head imaging, physical examination, pure tone audiometry, tympanometry and otoacoustic emissions on the day of reporting to the clinic. **Results:** At the follow up visit, patients had pure-tone audiometry and tympanometry. Only one patient showed a significant improvement in hearing after treatment. The remaining three only improved in one ear (all of them in the right). **Conclusions:** Bilateral sudden deafness should be treated as a warning signal of the possibility of a systemic condition. It requires further examination and referral to a specialist.

Candidacy for CI in case of asymmetric hearing loss in new-borns: What number can we expect?

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Objective: The objective of this study was to measure the number of paediatric CI candidates in new-borns with an asymmetric hearing loss with one deaf ear. We also want to compare the number of candidates with the real number of implantations in case of asymmetric hearing loss with one deaf ear. **Material and methods:** Flanders, the north part of Belgium, was in 1998 the first region in Europe to implement Universal Neonatal Hearing Screening (UNHS). During the period 1998–2016 (18 years) more the 1.1 million ears were screened and in 2445 baby's a permanent hearing loss was detected. Based on these data we had a clear overview on the expected number of cochlear implants in cases with asymmetric hearing loss. Since March 2015, paediatric cochlear implantation in case of asymmetric hearing loss is reimbursed in Belgium for children younger than age 12, who have a hearing loss of >85 dB in one ear and >60 dB in the other ear. The implantation also has to be done within 3 years after reaching these criteria. These expected data were compared with the actual number of CI's in cases with asymmetric hearing loss in 2017 and 2018. **Results**: Looking at the data from the UNHS carried out by the government of health care during the period 1998–2016, 2445 baby's had a permanent hearing loss. Of these baby's 1172 (48%) had a bilateral symmetric hearing loss, 736 (30%) an unilateral hearing loss and 535 (22%) had a bilateral asymmetric hearing loss. Of the group of baby's with an asymmetric hearing loss 181 (7.4%) had one deaf ear and 118 (4.8%) baby's fall within the Belgium CI-criteria. This means we can expect a yearly number of 12.5 new-borns with an asymmetric hearing loss and one deaf ear (or 1/12500 new-borns) of which 6.6 (52.8%) fall within the current Belgian criteria. But looking at the current number of asymmetric implantations in Belgium, we see that 28 children with an asymmetric hearing loss have received a CI in 2018. If only 6.6 of this group are new-borns with an asymmetric hearing loss, it means that 4 times more children in the asymmetric group were not candidates at birth, but have developed a progressive hearing loss in the early years. **Conclusions:** vLooking at the population of new-borns, we can expect that 1/12500 new-borns have an asymmetric hearing loss with one deaf ear and falls within the candidacy for cochlear implantation. But 3 times more children develop a progressive asymmetric hearing loss early in life, which means we have to multiply the new-born candidates with a factor 3 to estimate the real number of asymmetric paediatric CI candidates.

CBM's contribution towards accessible Primary Ear and Hearing Care: Results from Training of Trainers for Community Health Workers in India

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Background: CBM is a non-State actor in official relations with the World Health Organisation (WHO) since 1989 and,

as such, supports the design, revision, publication, dissemination and use of WHO's training resources and tools among its Member States, specifically in low- and middle- income countries. **Objectives:** To field-test the revised version of WHO's Primary Ear and Hearing Care training resources (PEHC-TR) alongside local field workers. This, by delivering Training of Trainers (ToT) workshops, obtaining participants' direct feedback and determining if the PEHC-TR are successfully updated to meet current needs for raising awareness and capacity building of Community and Primary Health Care workers. **Material:** WHO's revised (still ongoing) PEHC-TR were used for this TOT and field testing activity: specifically the "Basic Ear and Hearing Care Resource" and "Primary Ear and Hearing Care: Training Manual for health workers". Two TOT workshops were delivered during a three-days period to CHWs in Vellore and Mugalur. Facilitators included two experienced CBM advisors (one educator and one ENT surgeon) with ample experience in PEHC teaching, design/revision of training resources and public health interventions in low- and middle- income countries. Local facilitators included CBM partners: CMC-Vellore and St John's Hospital-Bengaluru, led by experienced Community Health Doctors, Audiologists and Hearing Aid Technicians. This activity was funded and supported by CBM-International Office in Germany and by CBM-Country Office (CO) in India, led by the India office team in coordination with local partners. **Methods:** Suitable dates were chosen, locations agreed, number of participants and background were defined. A mixture of 34 rural and remote tribal CHWs were selected for TOT in Vellore, which included different levels of training and experience in PEHC. For the TOT in Mugalur, it was decided to choose 20 rural CHWs with no previous experience or training in PEHC. Local organising teams received detailed information about the PEHC-TR, TOT objectives and practical issues. Live translation during ToT workshops and printed feedback questionnaires were provided into local languages (Tamil and Kannada). Feedback was produced as a combination of numeric responses to fifteen questions (rating 1 to 10) and narrative responses to six open questions. CBM CO-India kindly translated the narrative responses into English. **Results:** There was an overwhelming positive feedback reflected in the rating response from participants regarding the usefulness of these training resources for daily work and also their personal and community habits and living conditions. The contents of the PEHC-TR were found to be well chosen and comprehensive. The combination of multimedia theory teaching alongside practical demonstrations, individual exercises, role play in pairs and small group work, as well as being able to hear first-hand the experiences from persons living with hearing disability and to directly interact with health specialists, where all highlighted as key factors for the success of the TOT workshops and the good reception of the WHO PEHC-TRs. Constructive feedback was also provided for some specific contents to be revised or further adapted, however, there was no section of the manuals which was deemed to be irrelevant or unnecessary, from the participants' point of view. Detailed results of the feedback will be provided during this presentation, should it be accepted. **Conclusions:** This project's experience provides an excellent example to illustrate how CBM's technical and programmatic work contributes towards facilitating a natural and effective collaboration among stakeholders at international and country levels and specifically how Audiology and ENT professionals can contribute towards strengthening National Systems, as well as to the revision and dissemination of WHO-led training resources. Further PEHC-TR revision and field research into positive impact of these initiatives is still required, but consensus is that we are in the right track.

Chronic otitis media – is it more aggressive in children than in adults? Analysis of titanium PORP and TORP canal wall up tympanoplasties

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To examine hearing results in paediatric patients compared to adult population after canal wall up ossicular reconstruction with partial ossicular replacement prostheses (PORPs) and total ossicular replacement prostheses (TORPs) in chronic otitis media. A retrospective evaluation was performed on patients with chronic otitis media who underwent prosthesis ossiculoplasty between 2012 and 2016. Audiometry results were evaluated preoperatively and postoperatively for pure-tone average (PTA), air-bone gap (ABG) and method of ossicular reconstruction. ABG reduction to within 20 dB was established as success rate. Titanium prosthesis ossiculoplasty provides satisfactory hearing improvement. Paediatric population had worse prognosis regarding hearing improvement after PORP/TORP ossiculoplasty.

Clinic or home, does remote fine tuning versus in clinic follow up impact patient outcomes

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Many hearing aid manufacturers now offer tools for audiologists to be able to conduct remote fine-tuning of hearing aids. There are obvious benefits for patients to use remote fine-tuning, including, for example, saving time on travel. However, little is known about the outcomes of patients who utilize remote fine-tuning versus traditional, face-to-face fine-tuning. This talk will present the results of two studies investigating similarities and differences in patient outcomes when patients have follow-up visits using remote fine-tuning versus face-to-face follow-up visits. In one study, thirty hearing aid users were fit with hearing aids face-to-face by an audiologist. Half of the participants were assigned to a control group and came in after two weeks for face-to-face fine-tuning. The other half of the participants were assigned to an intervention group and were instructed to make requests for fine-tuning via a smartphone app. At the end of a six-week wear trial, independent samples t-tests showed no significant differences between the intervention and control groups for speech-in-noise tests, hearing aid benefit, or hearing aid satisfaction. Of note, however, is that 41% of the problems encountered by test participants were issues that required a clinic visit and could not be addressed by remote changes to the hearing instrument programming.

In a second study, fourteen hearing aid users were initially seen in a clinic and fit with hearing aids, face-to-face, by an audiologist. After one week, the test participants returned to the clinic for a second visit and were split into two groups.

One of the groups met in person with the audiologist for traditional, face-to-face fine-tuning. The other group used a smartphone app to request fine-tuning changes. Each group of test participants then wore the fine-tuned hearing aids for one to two weeks before returning for a third visit. At the third visit, the group that had previously been fine-tuned face-to-face then used the smartphone app to request fine-tuning, and the group that had previously been fine-tuned remotely met with the audiologist for face-to-face fine-tuning.

At the end of the trial, there were no significant differences between the two groups for an outcomes questionnaire nor in terms of relative speech-in-noise test improvements over the trial. Furthermore, real ear measurement results at the end of the study indicated no differences between the two groups. One interesting finding, however, was that, after the first fine tuning, real ear measurements showed that the group who underwent face-to-face fine-tuning had on average 1 dB smaller changes made to their initial fittings than the group who requested fine-tuning remotely. At the end of both studies, participants in each group did not differ significantly from one another on any of the outcome measures. These results suggest that remote fine-tuning tools can be used to offer audiological services without compromising outcomes. The studies, however, emphasize that remote fine-tuning should be used as a supplementary tool and not a replacement for face-to-face meetings which are still required to solve many patient problems.

Clinical utility of smartphone-based audiometry for early hearing loss detection in HIV-positive children: A feasibility study

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Background: Paediatric human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) often manifests with hearing loss (HL). Given the impact of HL, early detection is critical to prevent its associated effects. Yet, the majority of children living with HIV/AIDS (CLWHA) cannot access hearing healthcare services because of the scarcity of audiologists and expensive costs of purchasing screening equipment. Alternative solutions for early detection of HL are therefore necessary. **Aim:** The overall aim of this study was to assess the feasibility of using self-administered smartphone-based audiometry for early HL detection amongst CLWHA. Setting: This study was conducted at the paediatrics department of a state hospital in the Eastern Cape province, South Africa. **Methods:** This was a feasibility study conducted amongst twenty-seven (27) CLWHA who were in the age group of 6–12 years. The participants self-administered hearing screening tests using a smartphone-based audiometric test. The primary end-points of this study were to determine the sensitivity, specificity and test-retest reliability of self-administered hearing screening. **Results:** The sensitivity and specificity for self-administered screening were 82% and 94%, respectively, with positive and negative predictive values of 90% and 88%, respectively. Moreover, a strong positive test-retest reliability (r=0.97) was obtained when participants self-administered the screening test. **Conclusions:** Six- to 12-year-old CLWHA were able to accurately self-administer hearing screening tests using smartphone-based audiometry. These findings show that self-administered smartphone audiometry can be used for serial hearing monitoring in at-risk paediatric patients.

Clinically implementing online hearing support

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Background: Despite addressing the hearing impairment with hearing aids, many hearing aid users experience substantial communication difficulties that can affect their performance in daily life situations. This experience can be addressed with guided internet interventions. Such interventions have proven to be effective in minimizing hearing related problems. Most hearing aid users are neither aware of nor offered interventions beyond hearing aids. Thus, the overall availability of comprehensive audiologic rehabilitation is low.This study is a part of a collaboration between a national Care-Guide in Sweden and region Västra Götaland (VGR). The Care-Guide is a national website of health information and services for Sweden. Every region customizes its Care-Guide and includes online services. **Purpose:** The purpose of this study is to, via Care-Guide, provide needed online support to hearing aid users and to document the effectiveness of the online support compared to traditional support that the Hearing Organization, VGR, provides ("standard care"). **Methods:** This study included a randomized controlled trial (RCT) with an intervention group and a control group, and a focus group interviews with the participants. The intervention group underwent an online intervention while the control group received standard care. Later, the control group was offered same online intervention as the intervention group took part in. Both groups where offered to participate in focus groups interviews after completing the intervention. The Hearing Handicap Inventory for the Elderly (HHIE), the Communication Strategies Scale (CSS), the International Outcome Inventory for Alternative Interventions (IOI-AI) and the Client Oriented Scale of Improvement (COSI) as well as a self-designed questionnaire where used as outcome measures, before and directly after the intervention, and at 6- and 12 months post-intervention. **Results:** Preliminary results will be presented.

Cochlear implant outcomes reporting based on International Classification of Functioning Disability & Health for the Evaluation

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Introduction: International Classification of Functioning, Disability and Health, known as ICF, is a unified and standard language and framework for the description of health and health-related states. It defines components of health and some health-related components of well-being. ICF belongs to the "family" of international classifications developed by the World Health Organization (WHO) for application to various aspects of health. **Objective:** The aim of the study is to use the International Classification of Functioning, Disability and Health, known more commonly as ICF, as a clinical tool for planning and evaluating audiological rehabilitation after cochlear implantation. **Methods:** The HEARRING group links CI outcome measures to the ICF nomenclature, and thereby describe the findings from the ICF perspective. When linking data to the ICF, standardized linking rules were used. **Results:** Introducing the ICF nomenclature results in the development of a uniform language to describe health care after cochlear implantation, which serves to facilitate communication between different specialists and health professionals: physicians, speech therapists, psychologists, educators, engineers, and researchers. **Conclusions:** CI outcomes reporting system based on ICF allows to document amelioration of activity limitations and participation restrictions of people with hearing loss.

Cochlear implantation in Cogan's syndrome – a literature review

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Objectives: Cogan's syndrome is a rare disease of the inner ear and the eyeball. In several cases it may result in deafness, which may be treated with cochlear implantation. The aim of the study is to evaluate the effect of cochlear implantation in patients with Cogan syndrome based on the audiometric findings. **Material:** A literature research was held in English using key phrases: „Cogan's syndrome" or „Cogan syndrome" and „implantation" in scientific databases PubMed and Medline. **Methods:** The basic inclusion criterion was the description of hearing- and speech test results in patients with Cogan's syndrome before the implantation and after the implantation. Time criteria weren't used due to expected small number of the achievable articles. **Results:** In all papers a significant improvement of free-field hearing results was observed in patients after the implantation, no matter of the cochlear implant model. A gradual improvement in hearing abilities was noted along with the time from cochlear implantation. Regarding the speech audiometry, the results varied from 40% to 100% of speech intelligibility, with most of the patients achieving more than 80%. **Conclusions:** Cochlear implantation in patients Cogan's syndrome and concomitant deafness of results in significant improvement of hearing abilities. However, the literature is quite small and future studies are needed to conduct reliable metanalyses and draw firm conclusions.

Cochlear Implantation Outcome in Candidates with hearing thresholds below 80 dB

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Objectives: Technical and surgical improvements led to an expansion of audiological indication criteria for cochlear implantation. For these patients it is of particular interest to provide information on CI outcome. Hence, it was the aim of our study to determine the speech recognition after cochlear implant (CI) surgery for subjects with preoperative hearing threshold equal or better 80 dBHL. Additionally, we derived predictive factors for speech recognition with CI based on preoperative audiological measurements. **Material and methods:** Retrospective review of all adult patients who received a Nucleus cochlear implant in the ENT department of the University hospital of Erlangen between January 2010 and April 2019. The inclusion criteria were preoperative hearing threshold better or equal 80 dBHL on the ear to be implanted, German as native language, and at least six months CI rehabilitation in our center. **Results:** The inclusion criteria were met by 128 patients. All but two patients showed a significant improvement for speech recognition in quiet. Monosyllabic word score (WRS) improved by 55 percentage points. Three preoperative audiometric measures, the maximum word recognition score, age at implantation, and WRS65(HA), were identified as predicting factors for WRS65(CI). Three quarters of the CI-recipients did not score below the predicted WRS65(CI) minus 12 pp. **Conclusions:** For poor performing HA-users with a hearing loss equal or better than 80 dBHL cochlear implantation is an option when speech perception is insufficient. The prediction model supports counseling in this patient group.

Coherence and spectral analysis of the sentences that will be used in school age children speech comprehension test

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Introduction: Specification of the speech discrimination score on children is on instructive factor in hearing instrument choice and its pursit, besides it provides important information about the type and degree of hearing loss. There is no Turkish

sentence test on literacy intented for discrimination of children speech. On previos studies to discriminate school age children speech monosyllabic Word list has been made, however the necessity of generating sentence test has been occured as it will reflect natural life better on dialy life by using sentence communication instead of monosylabic words. **Material and methods:** Proper to 7–12 ages: the sentences gathered by the help on audiologst, pediatric development expert and class teacher have been recorded in a sound studio with 1 famele and 1 male speaker. The sentences knowability for the target age group is evalvated by being listened to 70 children in 7 regions of Turkey via sound record. These children's parents and additional disabled children have been ejected. First, chosen children's parents have been informed and studies have been carried our by negotiating with children face to face. In their habitat children have been asked to reply as I understand or I don't understand for each sentences they listened which were recorded previously in sound record studio. The results from all the regions have been gathered. The sentences that children heven't replied less than %80 spektral analysis of specified sentences has been made (in accordance to MATLAB2018a). **Results:** As the results of analysis, frequency intensity is 19–20 kHz, basic frequency degree 8.5–11 kHz. Spectral and coherence balanced sentences sterting from −30 dB to −130 dB have been acquired. **Conclusions:** In our study whether these analysis metods are the metods to from balanced sentence list that specifies equivalency or not has been researched. It has been foreseen that spectral and coherence analysis will be a new metod in forming balanced and equivalent sentence lists.

Communication and school readiness abilities of DHH children in South Africa: A retrospective review of EI preschools records

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Objective: The national prevalence of hearing loss in South Africa is estimated to be 4 to 6 in every 1000 live births in the public health care sector. An undetected hearing impairment in childhood can lead to delayed speech and language development as well as put the child at risk for not achieving the necessary school readiness abilities that will enable them to achieve academic success. However, through early hearing detection and intervention services, children who are deaf or hard of hearing (DHH) can develop communication and school readiness abilities on par with children with normal hearing. The aim of the study was to describe communication and school readiness abilities of children who are DHH and were enrolled in early intervention (EI) preschools in Gauteng. **Methods:** Within a descriptive research study design, a retrospective record review was conducted on files of eight children, ranging in age from 9 years; 7 months to 12 years; 7 months, who are DHH and were enrolled in EI preschools in Gauteng, South Africa. Descriptive statistics were used to analyze the data, using frequency distribution and measures of central tendency. **Results:** Current findings revealed that children who are DHH and were enrolled in EI preschools in Gauteng were identified late. This consequently led to delayed ages at initiation of EI services when compared to international benchmarks and HPCSA (2018) guidelines. Consequently, participants presented with below average communication and school readiness abilities, which are characteristic of hearing impairment that is late identified. **Conclusions:** Transference of current contextually relevant research findings into practice by both Departments of Health and Basic Education forms part of future directions from this study. This conversion of research findings into service delivery must be conducted in a systematic manner at all levels in these two sectors to facilitate achievement of EHDI, resulting in better communication and school readiness outcomes.

Community – based ear screenings through comprehensive ear care program "Shruti"

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Introduction: Hearing loss has been ranked as the fifth leading cause of years lived with disability which is higher than many other chronic diseases such as diabetes, dementia, and chronic obstructive pulmonary disease. Sixty-three million people (6.3%) suffer from a significant auditory loss in India. Access to ear and hearing health is a challenge in developing countries, where the burden of disabling hearing loss is greatest. Prevalence of CSOM in South Asia is 4.4% and India is burdened with the highest prevalence of children with CSOM in India. The study investigated community-based screening of ear and hearing related disorders using a telemedicine-based solution "ENTraview" operated by Community Healthcare Workers (CHWs). **Method:** A retrospective study was conducted from 2013 to Dec 2021 of all patients screened under the "Shruti-Comprehensive Ear Care Program". The program is operationalized through trained community health workers (CHW) equipped with an ENTraview. This device has a store and forward technology; there is an asynchronous communication in which the health workers obtain images and collect data from the patient. Patients with a positive provisional diagnosis are routed to the point of care for receiving low-cost treatment. **Results:** Data analysis was conducted on the results of 938,058 screened population through CHWs. Overall referral rate was 29% (271158). Overall referral distribution was 49% impacted wax, 21% otitis media, 14% diminished hearing, and 16% other ear disorders. **Conclusions:** Telemedicine-based hearing screening solutions can be used by CHWs to detect unidentified hearing loss within a community setting. Shruti has mostly been able to close this gap because it is a community-based program that is innovative, quick, and effective in screening and treating ear ailments.

Comparison of biphasic and triphasic programs in CI users with significant facial nerve stimulation

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Objectives: To evaluate program parameters and user performance and preferences with biphasic and triphasic programs. **Material:** Computer with MAESTRO 9.0.2 software; MAX interface; programming cables; cabin with implant sound field test equipment; and questionnaire. Demographics: 6 male and 6 female CI users (15 ears), average age 18 years (age range 10–33 years). **Methods:** Biphasic users (average length of use

8 years) who could not achieve desired loudness perception despite widening of pulses and switching off some electrodes who had been provided with a triphasic program were identified from a retrospective inspection of user files. At test session triphasic users (average length of use 1 year) had their triphasic programs and their most recently used biphasic program fine-tuned. These 2 programs were configured to the users' audio processors without informing the user about which program was which. Implant sound field thresholds were measured at 6 frequencies 0.25–6 kHz with each program. 6 users started with their biphasic and 6 with their triphasic programs. Users were given both programs to use and asked to try out both in varying listening conditions. After 2 weeks they were asked to score each program in terms of comfort of use and general like or dislike. A 5-point Likert scale was used, 0 indicating a very negative and 5 a very positive experience. **Results:** Average Maximum Comfort Level (MCL) across 15 ears and 12 electrodes was 30 qu for biphasic and 28 qu for triphasic programs. The profile of both programs tended to be flat. Rate of stimulation was compared for biphasic and triphasic programs in 9 ears where the number of active electrodes was the same for both programs. The average rate of the biphasic programs was 1,074 pps and for triphasic programs 1,238 pps. Number of active electrodes in each mode was compared for 15 ears, 4 ears used 1 more, 1 ear 2 more and 1 ear 3 more electrodes in triphasic mode as compared with biphasic mode. The average number of fine structure (FS) channels was 2 in biphasic and 4 in triphasic mode. The average implant threshold over 6 frequencies and 15 ears was 37 dBHL for biphasic and 30 dBHL for triphasic programs. The median subjective, score awarded by the users' concerning; experiencing discomfort in noisy situations; and general degree of liking was 3 for biphasic and 5 for triphasic programs. **Conclusions:** These CI users who required management of their facial nerve stimulation through programming preferred triphasic to biphasic programs. Triphasic programs accessed them to more sound and were more comfortable to use. The faster rate and increased number of FS channels likely lead to sound being perceived as more natural.

Comparison of two remediation approaches for Auditory Processing Disorder

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Aims: To compare the efficacy of a targeted auditory training program and device based management (remote microphone use) as a remediation approach for children diagnosed with an Auditory Processing Disorder. **Method:** 20 children aged between 7–12 years of age, diagnosed with an Auditory Processing Disorder (performance below 2SD on one or more tasks in a behavioral test battery, including the dichotic digit test) were enrolled in either an auditory training program (n=10) or fitted with a personal remote microphone system for use in school. Reading fluency, binaural-listening ability, auditory processing and cognitive skills were all assessed before commencing training, at the completion of training and twelve months post training. **Results:** Improvements (corrected for age) were seen across all measures on completion of the training program in both groups. Significant ($p<0.05$) sustainable improvements in binaural listening ability (a mean improvement of one standard deviation) were demonstrated in both groups. Only the targeted auditory training group showed significant, sustainable improvements in dichotic listening ability (3 standard deviations) and reading fluency (one standard deviation). The personal remote-microphone group showed significant long-term improvements in sustained attention ability (1.5 standard deviation improvement). **Conclusions:** Determining the management plan for a child diagnosed with an auditory processing requires a multi-faceted approach. As different approaches, can be shown to provide significant improvements in ability, factors such as presenting concern, classroom behaviour, time availability and financial constraints should be considered, alongside the presenting auditory processing deficit.

Congenital cholesteatoma in children – case presentations

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Introduction: Congenital cholesteatoma is a relatively rare disease especially in children. Unrecognized early, can cause major damage to middle ear elements, leading to hearing impairment or other complications. **Aim:** The aim of this work is the presentation of cases of congenital cholesteatoma in children, assessment of the results of surgical treatment and the possibility of early detection of this disease. **Material and methods:** Of the many thousands of ear surgeries performed annually in our clinic, a group of 149 patients aged 2 to 18 with a diagnosed congenital cholesteatoma, whose follow-up period was at least 3 years, was identified. Patients were divided into two groups: in group A were the youngest patients who were only able to perform objective hearing tests, and in less numerous group B older children, whom we could also do subjective studies. The majority of children were operated only from the external auditory canal, others from the dual access. Postoperative results were assessed as standard after 1, 6, 12 and 36 months. **Results:** The cure, understood as the removal of cholesteatoma, was obtained in all patients, however, to achieve this, sometimes more than one surgical procedure was needed. A noticeable improvement in hearing was obtained in the majority of children with reconstructed conductive apparatus. In patients from group B, closure of the cochlear reserve to 10 dB was obtained in 94.8% of cases. **Conclusions:** In the case of congenital cholesteatoma surgery success and postoperative results depend primarily on early diagnosis. In these cases we get very good results (removal of the cholesteatoma is relatively easy, and the middle ear hearing apparatus – undamaged.) All children who underwent surgery to remove congenital cholesteatoma have to be monitored (insightful video and microotoscopy, second look operations, HRCT) because despite the excellent tools and the progress of surgery, an uncontrollable recurrence of the cholesteatoma is possible.

Contralateral suppression of otoacoustic emissions in pre-school children

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Objectives: Contralateral suppression of otoacoustic emissions (OAEs) may serve as the index of the medial

olivocochlear (MOC) reflex. This effect was to this date studied in various populations but there is lack of data for preschool children. Therefore the purpose of this study was to fill this gap and describe the MOC reflex influence on the properties of transiently evoked OAEs (TEOAEs) in this age group. Additionally the influence of presence of spontaneous OAEs (SOAEs) on the suppression of OAEs was studied. **Material:** TEOAEs with and without contralateral acoustic stimulation (CAS) by white noise were measured in a group of pre-school children of age of 3–6 years, with normal hearing. **Methods:** The values of suppression, response levels and signal to noise ratios (SNRs) of TEOAEs were investigated for the whole signal (global) and for the half-octave frequency bands in 1–4 kHz range. Only the ears with SNR>6 dB were used in the analyses. Additionally SOAEs were acquired using the so-called synchronized SOAEs (SSOAEs) technique. **Results:** The ears with SSOAEs had higher Response levels and SNRs than ears without SSOAEs. Contrary to Response level and SNR the ears with SSOAEs had lower suppression than ears without SSOAEs. The average suppression of TEOAEs in children was around 8.5 for ears with SSOAEs and 0.6 for ears without SSOAEs. There was no effect of gender and age on suppression. **Conclusions:** Suppression levels for pre-school children do not differ much from that of adults measured under similar conditions in other studies. Taking it together with no effect of age in data studied here it seems to be no effect of aging on TEOAE suppression. However there was influence of SSOAEs on suppression which was not reported in earlier studies in different populations.

Cortical auditory evoked potentials in children with microcephaly related to Zika virus

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Objective: To analyze the cortical auditory function of children with microcephaly in Zika virus congenital syndrome through cortical auditory evoked potentials. **Material and methods:** In a cross-sectional study with 15 children (controls – G1) and 15 children (8 boys, 18–30 months-old) with microcephaly (G2), cortical auditory evoked potentials (CAEPs) were elicited by speech stimuli /ba/ and /ma/, randomized 1: 1, and recorded in both brain hemispheres. The Kolmogorov–Smirnov test was used and according to the data distribution of each variable, parametric or nonparametric tests for independent samples (Student's *t* and Mann-Whitney, respectively) were used. **Results:** Through the stimulus /ba/, children with microcephaly (G2) showed higher P2 amplitudes than controls (G1) in the left brain hemisphere (p=0.018); higher N2 amplitudes in both brain hemispheres (p=0.040 and 0.021, right and left, respectively). Through the stimulus /ma/, G2 showed higher P1 amplitudes than G1 in both brain hemispheres (p=0.011 and 0.005, right and left, respectively); higher P3 latencies in both brain hemispheres (p=0.045 and 0.011, right and left, respectively). **Conclusions:** These results are consistent with immature patterns in auditory cortical activities impairing the detection and the inhibitory control of acoustic stimuli demonstrated by CAEPs in children with microcephaly related to Zika virus.

Cross-modal activity and relationship to functional speech outcomes in post-lingual cochlear implant users

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Objectives: Cortical reorganisation as a result of deafness has been proposed as a potential contributor to variability in cochlear implant (CI) outcomes. Specifically, cross-modal activity in auditory and visual cortices has been shown to correlate with auditory-only speech understanding in post-lingually deaf CI users. However, it remains unclear whether these associations are 'adaptive' or 'maladaptive' for functional outcome, with varied associations reported. Importantly, there has been variability across studies in the types of visual and auditory stimuli used, e.g., 'basic', such as gratings and noise, vs. 'speech-based' visual and auditory stimuli, which are likely to engage different cortical networks. This study therefore aimed to; 1) examine activations in temporal and occipital regions using two paradigms, one with basic stimuli and one with speech-based stimuli, in the same cohort of post-lingually deaf CI users, and a group of age-matched, normally-hearing controls, and 2) investigate whether a relationship exists between 'cross-modal' activation and speech recognition measures in auditory, visual-only and audiovisual conditions, and whether this changes depending on the paradigm used (basic vs. speech). **Methods:** fNIRS was employed as a non-invasive technique that is not susceptible to electrical or magnetic artifacts common to other neuroimaging methods such as EEG and fMRI. Two test paradigms were administered in a block design, using i) basic auditory and visual stimuli – modulated speech-shaped noise and morphing concentric gratings, and ii) speech stimuli – concatenated IEEE sentences presented in an auditory-only and a visual-only condition. Responses were measured via a 52-channel optode array positioned over temporal and occipital regions. Speech recognition performance on IEEE sentences were assessed in auditory-only, visual-only and audiovisual conditions. **Results:** Group-level analysis using a general linear mixed effects model indicated significant activations across both groups, paradigms and conditions. Activations were observed in temporal areas to auditory stimuli and in occipital areas to visual stimuli in both groups as expected, for both basic and speech-based stimuli. Significant 'cross-modal' activation in temporal regions was observed at the group level to visual speech in both normally-hearing controls and CI users. Spearman's rank-order correlation was used to investigate the relationship between cortical activity and speech recognition performance in auditory-only, visual-only and audiovisual modalities. While no significant relationships were found between auditory-only speech performance and cortical activity in this cohort (unlike that found in previous studies), a significant positive relationship between performance on a visual-only

(lip-reading) speech task and activation of the left temporal region, as well as the angular gyrus and supramarginal gyrus (both associated with higher-level language functions), was observed in the CI users only. **Conclusions:** Evidence of differential activations depending on the nature of auditory and visual stimuli used was observed between this cohort of post-lingually deaf CI users and normally-hearing controls. In particular, left temporal 'cross-modal' activation to visual speech stimuli was observed in both normally-hearing controls and CI users. Correlational analysis also indicated a significant positive relationship between performance on a visual speech (lipreading) task and activation of temporal and language-associated regions to the visual speech stimuli, in CI users. Together, these findings support existing evidence that activation of brain regions typically associated with language processing are not necessarily modality-specific (i.e. can be elicited by purely visual stimuli), and have implications for the interpretation of auditory-visual cross-modal activity and the relationship with functional speech outcomes, particularly where language-based stimuli are used. A clearer understanding of how cortical activity relates to functional speech outcomes could enable more targeted interventions to be developed, in order to optimise auditory rehabilitation programs for CI users and shed further light on variability in individual outcomes.

Development of an AAV-Based Gene Therapy for Children with Congenital Hearing Loss Due to Otoferlin Deficiency (DB-OTO)

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Background: Otoferlin is a calcium sensor protein expressed in the inner hair cells and is important for proper synaptic transmission between inner hair cells and the afferent fibers of the spiral ganglion. Biallelic loss of function mutations in the OTOF gene lead to congenital severe-to-profound auditory neuropathy in both humans and in mice. These mutations are believed to be causal in 2–3% of individuals born with hearing loss. Infants with biallelic OTOF mutations are currently managed with assistive devices, but several groups are developing AAV-based gene therapies to address this population. **Methods:** We have developed DB-OTO, an Adeno-Associated Virus (AAV)-based gene transfer therapy for rescue of hearing in Otoferlin deficiency. DB-OTO expresses a corrected OTOF cDNA from a hair cell-specific Myo15 promoter and is delivered using an AAV1-based capsid. Because human OTOF cDNA exceeds the packaging capacity of a standard AAV, DB-OTO uses a dual AAV system to reconstitute the full-length OTOF coding sequence. **Results:** We have previously shown that DB-OTO can rescue hearing function in OTOFQ828X/Q828X mutant mice as measured by ABR, that it can be successfully delivered to the primate ear via RW infusion with vestibular fenestration, and that using a cell-specific promoter is key to its function. Here, in preparation for the initiation of clinical studies, we further characterized the dose translatability of DB-OTO between mice and non-human primates. To better characterize the dose-response of DB-OTO, we dosed mice over a >10× dose range and evaluated their hearing recovery over several months. We found that at higher doses, tone-burst response in previously deaf OTOFQ828X/Q828X mice extends to the apex of the cochlea, whereas with low doses, the best recovery is seen around 22 kHz. We also treated OTOFwt/wt mice to characterize the tolerability of DB-OTO over the same dose range. Using RT-PCR, we showed that DB-OTO expression increases continuously for the first several weeks after dosing in mice, consistent with functional recovery. In parallel, we evaluated the expression timing in non-human primates using the same assay. There, the expression appeared to plateau in a comparable timeframe following dosing. Using this assay, DB-OTO expression levels at plateau in mice and primates were compared and used to confirm prior assumptions about dose translation based on expression from surrogate vectors. Together, these data support and inform our plans for clinical translation of DB-OTO. **Conclusions:** DB-OTO is a promising emerging therapeutic for genetic hearing loss and has the potential to provide the first clinical proof-of-concept for gene therapy in the inner ear.

Development of living practice guidelines for cochlear implantation in adults

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Objectives: International guidelines and clearly defined care pathways on adult cochlear implantation (CI) are limited, and country-specific guidelines vary and are associated with disparate levels of access and systemic underuse across the world. In 2020, consensus statements were published representing the first step toward the development of international guidelines on best practices for CI in adults with severe to profound sensorineural hearing loss (SPNHL). The standard of care for adults with hearing loss should include treatments that best improve the individual's quality of life through optimizing hearing function, social participation, and engagement. For adults with SPNHL, the standard of care includes an accurate diagnosis and timely referral to an appropriate specialist centre for assessment and counselling. When it is indicated as the most beneficial treatment option, the patient should be advised by an appropriate healthcare professional about access to cochlear implantation (CI) and aftercare. **Material and methods:** An international group of CI users and experts in the fields of otology, audiology, and hearing care have been brought together to form a Task Force in partnership with the Cochlear Implant International Community of Action (CIICA). The aim of the Task Force is to develop living practice guidelines and guidance that can be adapted and adopted in country, in order to optimise the care for adults indicated for CI. Member affiliations will extend to national and international organisations and a wide range of stakeholders implementing hearing care solutions within the community and most importantly patient representatives with SPSNHL. **Objective:** The overall objective of the Task Force is to contribute to and support the effective development and subsequent dissemination and adoption into practice of a set of accurate, consistent, and usable guidance and guidelines.

Results: As the guidance and guidelines will need to be updated as new evidence is published, the aim of the Task Force is therefore for continuity and evolution over the long-term. Developing a consistent approach to optimizing the care for hearing impaired adults who may not receive adequate benefit from hearing aids will help raise awareness and better define referral and treatment pathways, so patients can receive information about a treatment option that may help them.

Dichotic listening in children with developmental dysphasia

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Introduction: The aim of our study was to analyse the role of auditory perception in children suffering from developmental dysphasia (DD) using central dichotic tests. The dichotic listening task consists of a series of paired stimuli presented simultaneously, one to each ear. APD (auditory processing disorder) may occur in children with specific language impairment, with learning disabilities and with attention deficit. **Material and methods:** We have focused on results of dichotic listening in preschool children (208) with DD and in older DD children with learning disabilities (113). We compared these findings with results of normal developed children. Several types dichotic tests were used (two-syllable words or short sentences). Results of dichotic listening evaluate the percentage rate of success of the words recognized. **Results:** Average rate of succes (in dichotic word listening) of DD children in the age of 6–7 y. was: 53.3% in test 1; 59.8% in test 2 and 58.2% in test 3. Rate of success of the control group was: 90.8%, 92.9% and 91.6%. Results of the dichotic sentence tests in older DD children with learning disabilities were: 52.5% and 57.3%. Rate of success of the control group was 92.1% and 87.5%. **Conclusions:** The findings of preschool aged DD children confirmed disability to synthesize 2 two-syllabic words during dichotic listening. Results of the dichotic tests in children confirmed integration problems in the central perception area and the short-term memory disorder. Our findings confirm difficulties of children with developmetal dysphasia with auditory processing; as it relates to language function. The children exhibit a bilateral processing deficiency that results in their language and learning disabilities (they have central integration problems and short-term memory disorder).

Directional preponderance – its diagnostic value – possibilities and restrictions

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The aim of the study was to describe the usefulness of the caloric directional preponderance in diagnosis of the peripheral and central vestibular disturbances. The examination was performed in 150 cases of the peripheral dysfunctions (labyrinth lesions in chronic otitis media, vestibular neuritis, Meniere's disease, temporal bone fracture) and the group of central vestibular disturbances (central nervous system tumors, multiple sclerosis, vestibular brainsteam insufficiency, epilepsy, arteriosclerosis). Vestistibular – oculomotor reflexes were registered in electronytagmography and videonystagmography. Directional preponderance was done using Jongkees proposals. Directional preponderance was observed in 45.9 patients with peripheral lesions and in 51.5% of 'central cases'. Directional preponderance alone was present in 29.1% in peripheral and 43.2% in the central dysfunctions. The coexistence of directional preponderance and spontaneous or/and positional nystagmus was observed in 29.1% of peripheral cases and in 20.3% with central lesions. In the majority of cases directional preponderance, spontaneous and positional nystagmus directions were the same. The results of the study suggest the usefulness of directional preponderance in the evaluation of vestibular compensation, the directional preponderance is in accord with the direction of spontaneous and positional nystagmus in the peripheral lesions in the most cases, but opposite in central dysfunctions. But one must take into consideration that directional preponderance is present in peripheral and central vestibular disturbances – it is the essential limitation of this phenomenon for determination of the vestibular dysfunction level. The directional preponderance mechanism is still unclear.

Do experienced cochlear implant users benefit from automatic preprocessing and would they like of-the-ear processor placement?

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Intoduction: Cochlear Implants (CIs) can provide hearing to prelingually deaf children and to people, at any age, who do not get sufficient help from common hearing aids. A CI system includes the implanted part with an electrode array positioned in the cochlea and an external sound processor commonly worn behind the ear (BTE). Recently, some manufacturers have also introduced "of-the-ear" (OTE) processors that are integrated with the transmitting coil on the head over the implant. The Kanso sound processor is the first OTE processor from Cochlear. Also, The CI manufacturers continuously improve stimulation strategies and signal processing in order to improve the recipients' hearing ability. During the last years, most improvements of signal processing have been directed towards preprocessing of the audio signal. With the Nucleus 6 system the Cochlear company introduced SCAN, which is an automatic selection of input sound processing settings based on the actual sound environment. Although a few studies have indicated improved performance with SCAN, clinical experience have shown divergent reports from the users. For clinicians who select and fit CI processors, it is important to know if patients usually benefit from or prefer the one or the other setting or design.

Objectives: The aims of this study were to compare subjective preference and speech recognition performance between SCAN and fixed preprocessing and to compare the OTE processor Kanso (CP950) with Cochlear's newest BTE processor Nucleus 7 (CP1000). **Material:** Twenty-two subject were included in the study in connection with their upgrading from the old Freedom processor to a new device. They should have used a Freedom processor for more than one year and have reached an open set word recognition better than 50%. **Methods:** The study design was prospective crossover with two months between the interventions. Tests were performed using the subjects' preferred setting on the Freedom processor. The N7 and Kanso processors were programmed using the same T- and C-levels as used for the Freedom and with SCAN always activated. Sound-field thresholds, word recognition scores at 50 and 65 dB SPL and Hearing In Noise (HINT) thresholds were obtained at the three visits. Subjectively rated performance was recorded with the SSQ questionnaire at each visit. At the last visit the participants also compared the two new processors using a specific questionnaire and made their final choice of new processor. **Results:** Twenty of the 22 participants completed the study. Two discontinued because they could not accept the sound image variations caused by SCAN. Speech recognition scores in quiet were similar for all tree processors at 65 dB SPL, but at 50 dB SPL the average result with Kanso was slightly worse compared to Freedom and N7. HINT results showed better results with Kanso and N7 than with the Freedom processor. The SSQ scores rated the processors in the order: Nucleus 7, Freedom, Kanso. At the final visit, all but one subject chose the N7 processor. **Conclusions:** Speech recognition results at low level in quiet were slightly worse with the Kanso "of-the-ear" processor. The automatic preprocessing SCAN improved speech recognition in noise. Only one of 20 experienced CI users selected the OTE processor Kanso instead of the BTE processor N7. Some CI users may not accept the variations in acoustic image caused by SCAN.

Do we need different first fit strategies for different coupling options of AMEI's?

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Objectives: The Floating-Mass Transducer (FMT) of the Vibrant Soundbridge (VSB, Med-El, Austria) provides several coupling options to amplify stapes motion. Different couplers might result in different output and therefore might require an adaptation of precalculated gains during first fit. The aim of this experimental study was to compare the vibratory output of the three following couplers i.e. short process (SP), long process (LP) and stapes head (SH) coupler. **Material and methods:** The FMT output was measured using Laser Doppler Vibrometry in a frequency range between 100 and 8'000 Hz at the stapes and the round window. The first part of the study was performed in 10 human temporal bones. We compared directly the output of the SP, LP and SH couplers in the same specimen. The FMT was attached to the ossicular chain according to the surgical guidelines of the couplers. In the second part of the study, we simulated potential surgical failures of the LP and SP couplers in a real size mechanical middle ear model. For the LP and SP coupler we measured the output with a reduced coupling to the ossicle or with a contact of the FMT to a solid structure to estimate sources of variability. **Results:** Temporal bones: A first comparison between SP and LP coupler shows a maximally 10 dB higher magnitude for the LP coupler at the stapes and the round window for frequencies below 600 Hz. The SP coupler shows a maximally 20 dB higher magnitude at the stapes and round window for frequencies above 600 Hz. Another comparison between LP and SH coupler at the round window showed that the SH coupler provides in a significant higher magnitude of up to 18 dB in the frequency range between 1020 to 3700 Hz. For frequencies between 380 to 500 Hz the SH coupler is significantly lower (maximally 11.7 dB). Mechanical middle ear model: A contact of a solid structure with the FMT results in a damping of up to 20 dB for frequencies between 300 Hz and 900 Hz for the LP coupler but no damping was observed for the SP coupler. Additionally reduced coupling of the FMT to the ossicles deteriorated the output more for the LP than for the SP coupler. **Conclusions:** The fitting software of the VSB does not explicitly differentiate between LP, SP, SH couplers. Our experiments show that the outputs of the SH and SP coupler measured at the round window was similar over across most of the frequencies. Therefore, a differentiation between SP and SH couplers to calculate first fit gains seem not to be needed. However, the output of the LP coupler was significantly different from the SP and SH coupler such that a different calculation of the first fit gain for the LP coupler seems to be advisable. In case of reported surgical limitations the first fit gain of the LP should be increased while no such an adaptation seems to be needed for the SP because of less vulnerability.

DPOAEs and hfPTA in the detection of ototoxic cochlear damage

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Objectives: In adults with MDR-TB receiving ototoxic medication to determine which stimulus parameters elicit the (1) largest distortion product otoacoustic emissions (DPOAEs) and (2) the most sensitive and specific DPOAEs. Design: A single group, repeated measures design. Stimulus parameters included L1/L2=65/65-, 65/55- and 60/53 dB SPL and f2/f1 ratios of 1.22, 1.20 and 1.18. Study sample: A convenience sample of 21 participants, i.e. 15 females and 6 males, aged 18 to 46 years with conventional pure tone hearing thresholds within normal limits. **Results:** Descriptive statistics and mixed model analysis showed stimulus intensity levels L1/L2 of 65/55 dB SPL and 65/65 dB SPL, and f2/f1 ratios of 1.18 and 1.20 elicited the largest DPOAEs. The stimulus combination of L1/L2=65/55 dB SPL f2/f1=1.18 showed the largest reduction in DPOAE levels between test 1 and test 2. When examining individual changes in pure tone thresholds from 10 to 16 kHz (using ASHA, 1994), out of 42 ears, thresholds in 9 ears deteriorated, 25 ears' thresholds stayed the same, and in 8 ears the thresholds decreased (meaning that the hearing

improved). With DPOAEs across all stimulus parameters, out of 42 ears, on average, the level decreased in 14 ears, stayed the same in 21 ears and increased in 7 ears. On average, in more than half the ears (54%) there was correspondence between the DPOAE results and pure tone thresholds indicating no clinically significant changes. DPOAEs decreased significantly between the two test sessions for 11 to 15 participants (depending on the f2/f1 ratio), where pure tone thresholds remained the same or improved. **Conclusions:** The study concluded that for ototoxicity monitoring, it is advised to use stimulus parameters of L1/L2=65/55 dB SPL and f2/f1=1.18 to detect cochlear damage the soonest, in conjunction with high frequency audiometry. If either test is used in isolation, there is a chance that ototoxic damage might go undetected.

Early clinical experience of the Cochlear™ Osia® System

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Objectives: To evaluate the experience with surgical and fitting aspects of the Cochlear™ Osia® System by practicing surgeons and audiologists. **Material and methods:** The Osia System is an active osseointegrated steady state implant system and includes the Osia 2 Sound Processor and the Osia OSI200 Implant, which is attached to the bone using an osseointegrated BI300 Implant. 20 Osia Systems were implanted by 7 clinics in an early clinical release. Within this period, surveys were collected to monitor the clinicians' experiences on the surgeries performed and initial fittings. At the end of this period, a closure survey was collected to evaluate the clinicians' overall feedback. **Results:** Data consisted of 20 implantations of the Osia System. Patients included children (35%) and adults (65%). Implantations took 60 minutes on average, where a trend was observed on decreased surgery duration with increased surgeon experience. Three incision options were recommended so that incision techniques varied from surgeon to surgeon. Bone polishing was performed in 65% of the surgeries. Skin thickness was 9 mm or less in most of the cases and therefore, soft tissue thinning was only performed in 10% of the implantations. Overall, in 85% of the surgeries, surgeons agreed or were neutral on the ease of handling and insertion of the Osia OSI200 Implant. Initial fittings were conducted with 13 patients. The average sessions lasted 55 minutes, with the actual programming taking 25 minutes. 92% of the patients rated the loudness of their first hearing experience as comfortable. In 92% of the initial fittings, audiologists agreed that the Osia 2 Sound Processor was easy to fit. 92% of the patients or their families were satisfied with the Osia System overall after the session. The final feedback revealed that participating clinicians favourably rated Osia System features, especially for the Osia 2 Sound Processor. **Conclusions:** Early experiences indicated a high acceptance of the Osia System by practicing surgeons and audiologists and a high satisfaction of recipients or their families. The lower surgical complexity of the Osia OSI200 Implant compared to the OSI100 Implant was reflected in an at average decreased surgery duration.

Economic evaluation in HTAs: A cost-utility analysis of BCIs – a decision analysis

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Background: On 29 September 2021, the heads of 19 European HTA agencies came together and inaugurated a new HTA-focused collaborative network for high-level strategic exchange and discussion to step forward towards a new framework for HTA. As HTAs seeks to inform health policy makers to take informed decisions on pricing or reimbursement by using the best scientific evidence on the medical, social, economic, and ethical implications, health economic evaluations are becoming increasingly important. A cost utility analysis (CUA) is one type of health economic evaluation that can help to compare the costs and effects of alternative treatment options and therefore suited to compare different bone conduction implants (BCIs), in terms of costs and outcomes within certain country settings. The aim of such analyses is to express the value for money in a single type of health outcome and to support decision makers in finding the most sustainable funding decisions on BCIs. BCIs are commonly used for auditory rehabilitation in patients with conductive or mixed hearing loss (C/MHL) or single-sided deafness (SSD). Currently percutaneous BCIs are perceived to be the most utilized and least expensive BCIs and therefore considered standard of care; however, data has shown that patients implanted with a percutaneous BCI have an increased risk of recurrent side effects which are identified as major cost-drivers to health care systems. To overcome these issues transcutaneous BCIs (with intact skin) were developed. **Objectives:** Designing a cost-utility analysis to determine the quality of life and cost consequences for patients with conductive or mixed hearing loss (C/MHL) or single-sided deafness (SSD) who received a bone-conduction implant. **Material and methods:** In cost-utility analyses, Markov models are widely used and often analyzed as microsimulations (simulation of individual patient data) to estimate the incremental cost utility ratio (ICUR) of, e.g., transcutaneous active BCIs compared to percutaneous BCIs in individuals with C/MHL or SSD. Cost data needs to be derived within a country specific model framework, depending on the payer's perspective. Effectiveness data can be mostly derived from published literature. Often third-party payer perspectives are adopted, and discount rates applied varying from 3–5% to consider the time value of money, depending on the country specific setting and time horizon used. The time horizon used in such an analysis should be of sufficient length to capture all costs and effects relevant to the decision problem, usually varying between 3 years (short-term) and 10 years or more (mid- to long-term). **Results:** To summarize the relative cost-utility of BCIs, outcomes are reported as an incremental cost utility ratio (ICUR), resulting in the costs per additional QALY gained. For example, in a CUA analyzed within a Turkish setting, percutaneous BCIs generate 3.62 QALYs, while transcutaneous active BCIs generate 7.14 QALYs. Since

transcutaneous active BCIs cost about €2,000 more than percutaneous BCIs, the ICUR would be €2,000 (incremental costs EUR) divided by 3.52 (incremental effect QALYs), resulting in a cost per QALY of €570. **Conclusions:** Following the described example, by using a time horizon of 10 years within a Turkish setting transcutaneous active BCIs offer a safe and cost-effective solution compared to percutaneous BCIs in adults and children with C/MHL or SSD. In this scenario, the ICUR was favorable to transcutaneous active BCIs compared to percutaneous BCIs at €570 per QALY, indicating that in 99.4% of all samples transcutaneous active BCIs were considered cost effective when comparing to current standard of care (percutaneous BCIs). From the point of view of the new EU-HTA regulations analyses like the one presented above can contribute to a more valuable resource allocation across Europe.

Effect of hearing aid use on temporal processing in conductive hearing loss

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Objective: The chronicity of the problem in conductive pathologies, the lack of improvement with treatment and the progression of hearing loss are seen as an important criteria for using hearing aids. The aim of this study was to investigate the effect of conductive pathologies on temporal resolution and the use of hearing aids. **Material and methods:** Of the 70 patients with mild to moderate conductive hearing loss, 24 patients with bilateral, 22 patients with unilateral hearing aids users and 24 patients with no hearing aids were included in the study. 30 healthy subjects were included as a control group. After the complete audiological test battery, gaps in noise, duration pattern and frequency pattern tests were performed for temporal processing. **Results:** There was no significant difference in temporal processing test performance between bilateral and unilateral hearing aids users when compared with normal hearing. However, the results of patients with long-term conductive hearing loss who had never used hearing aids was significantly lower when compared with the hearing aid users group and the control group. **Conclusions:** As a result of this study, although the cochlea and auditory nerve are intact in long-term conduction pathologies, the existing hearing loss may lead to auditory deprivation and temporal processing may be affected. Early intervention with appropriate amplification in conductive pathologies may contribute to the temporal processing.

Effect of noise on speech comprehension and cognitive skills by ages

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Objectives: The aim of this study was to determine the speech comprehension performance in noise, to evaluate short-term memory and working memory capacity in a noisy environment with an innovative approach in young and old individuals with normal hearing. In addition, the relationship between speech comprehension in noise and cognitive skills was to exam. **Material and methods:** 25 young adults with normal-hearing (18–40 years) and 21 elderly adults with normal-hearing (55–70 years), a total of 46 participants, were included in the study. Turkish matrix sentence test was applied to the individuals included in the study as speech comprehension test in noise. The short-term memory by forward digit span task, working memory by backward digit span task were measured. These tasks were performed in a quiet and noisy environment (0 SNR). **Results:** In the young group no statistically significant difference was observed in the forward and backward digit span tasks in quiet and noisy environments ($p>0.05$). In the elderly group, low results in noise were obtained in forward and backward digit span tasks and a statistically significant difference was observed ($p<0.05$). Turkish matrix sentence test results and short-term memory and working memory tasks in both listening conditions were lower in the elderly group compared to the younger group and a statistically significant difference was obtained ($p<0.05$). There was no relationship between Turkish matrix sentence test and forward, backward digit span tasks in the young group ($p>0.05$); there was a moderate negative correlation between Turkish matrix sentence test and forward digit span task in the elderly group ($p<0.05$). **Conclusions:** While short-term memory and working memory tasks capacity of young individuals was not affected by noise; it was determined that the elderly was affected by noise. The short-term memory and working memory tasks capacity of the elderly group was found to be lower in both settings compared to the younger group. In the elderly group, there was a correlation between short-term memory and working memory in the quiet environment, whereas the correlation was lost in the noisy environment.

Effect of presbycusis and tinnitus on the auditory pathway and auditory – limbic connections

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Intorduction: Age related hearing loss (presbycusis) presents itself by elevated auditory thresholds and decreased speech intelligibility especially in a noisy environment. Occurrence of tinnitus (phantom noise) commonly coincides with the onset of presbycusis. Although both are believed to originate from the auditory periphery, they have several functional and morphometric effects also in central parts of auditory and limbic system. **Aim:** The aim of our project is to identify possible changes within the white matter of auditory pathway above

inferior colliculus (IC) and also within the connections towards the limbic system (amygdala). **Material and methods:** Six groups of volunteers were used in this study: elderly with expressed presbycusis, elderly with mild presbycusis, young controls, elderly with expressed presbycusis and with tinnitus, elderly with mild presbycusis and with tinnitus and subjects with normal hearing and with tinnitus. Tractographic data were acquired using a 3 T Siemens Tim Trio system (Siemens), with a 12-channel head coil. Streamline tracking was performed on common FOD template using probabilistic algorithm iFOD2. Spherical masks on both inferior colliculi were defined manually. Mask of the Heschl gyrus was obtained by applying morphing of Destrieux atlas mask of one representative subject to FOD template. These masks were used as ROIs for targeted exploratory tracking and definition of fixel mask). Fixel based analysis was used for detection of changes (using connectivity-based fixel enhancement, family-wise error corrected) in the following three metrics: fibre density, fibre cross-section, fibre density and cross-section. **Results:** We were able to identify auditory pathway above the level of IC, and connections from IC towards the amygdala and from AC to amygdala. The only observed changes of the white matter within the auditory and auditory – limbic pathways were due to ageing. No statistically significant changes due to hearing loss were found. Tinnitus caused a borderline change in the part of the pathway from the inferior colliculus toward amygdala. **Conclusions:** This is probably the first study using fixel based analysis in the auditory system. Although we were bale to identify age related changes within the studied tracts, in all used metrics, no hearing loss related changes were present. The presence of borderline tinnitus changes in the adjacent pathway from the inferior colliculus to amygdala support the idea of involvement of the limbic system in the tinnitus network.

Effect of rehabilitation training based on temporal fine structure on perception speech in noise on elderly with mild to moderate hearing loss

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Background: Age related hearing loss (Presbycusis) is the most common form of hearing loss in the over 60 year olds, and has a negative impact on quality of life. The cause of Presbycusis is multifactorial and is predominately characterized with loss of speech perception in noise. Sounds are decomposed by the auditory filters to slowly varying envelope (E) and rapid temporal fine structure (TFS). TFS is important for recognition of target speech in noise. **Objective:** The main aim of study is to, the effect of rehabilitation training based on temporal fine structure on speech in noise perception on patients over the age of 60 years with mild to moderate hearing loss. **Material and methods:** A randomized clinical trial will be conducted on the patients with mild (loss of 20–39 dB) to moderate (40–69 dB) hearing loss and age between 60–75 years old. We excluded patients with conductive hearing loss, abnormal middle ear pathology and Central Nerve disease (CNS). The patients randomly were selected in to intervention and control group with 1: 1 ratio. Sample size was calculated with twelve patients in each group. The rehabilitating period for intervention group will be thirty minute sessions three times a week for a total five weeks. In beginning and at the conclusion of study in both intervention and control groups the Signal to noise ratio (SNR), Binaural TFS test and Speech, Spatial and Qualities of Hearing Scale (SSQ) questionnaire score will be performed to evaluate the effect of rehabilitation training on intervention group. In rehabilitation training the test consist of 16 consonants to identify vowel consonant vowel words (vcvs) which partially transmitted by TFS. **Results:** The results of study will be presented in the meeting. **Discussion:** Since the number of older persons is increasing. Presbycusis is growing very rapidly worldwide. Presbycusis mostly is caused by TFS damage. Most of the studies indicated this damage is permanent but in this study we attempt to prove base on rehabilitation training part of impairment in TFS information will be restored. The study is not completed yet but we are very ambition to show our results in XXXV World Congress of Audiology.

Effectiveness of tympanostomy and adenoidectomy in comparison with non-surgical approach in children who suffer from OME in 12-month period

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Background: Otitis media with effusion (OME) is one of the most common disease in childhood. The objective was to assess clinically the effectiveness of the surgical approach (tube insertion with adenoidectomy) in comparison with the non-surgical approach (watchful waiting) in the 12 months observation period. **Methods:** This study was retrospective and obtained the approval from the bioethics committee. The criteria of inclusion in the first group (surgical approach) were: (1) a diagnosis of chronic otitis media with effusion in children at the age between 1 and 6 years; (2) their medical history showed they had undergone adenoidectomy and tympanostomy with the insertion of VTs (Ventilation tubes). The criteria for inclusion in the second group (non-surgery) was similar to the first group except that their medical history showed they had not undergone adenoidectomy or tympanostomy with the insertion of VTs. There were 422 children included in the surgical group and 50 children in the non-surgical group and the period of observation was 12 months. **Results:** For the entire surgical group the number of healthy days ranged from 20 to 365, with mean of 328.0 days (*SD*=91.4) In the non-surgical group, the number of healthy days ranged from 13 to 365, with mean of 169.2 days (*SD*=127.3). The difference between the number of healthy days was statistically significant ($p<0.001$). The certainty of treatment in the first group was higher than in the second group, and the number of days without recurrence was significantly higher than in the second group. In the first group, there were 71 recurrences from 422 children (16.8%) and in the second subgroup there were 40 recurrences of AOM (Acute otitis media) from 50 children (80%). The RR was 0.21. **Conclusions:** The surgical approach in children aged 1–6 years who have been diagnosed with otitis media with effusion reasonable and beneficial for the child.

Effectiveness of various treatments for Sudden Sensorineural Hearing Loss – a retrospective study

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Background: A retrospective clinical study was conducted to compare the effectiveness of different pharmacological and non-pharmacological regimens for treating sudden sensorineural hearing loss (SSNHL). **Methods:** Adult patients (*n*=130) diagnosed with sudden sensorineural hearing loss (SSNHL) and hospitalized between 2015 and 2020 were enrolled in this study. Depending on the treatment regimen applied, patients were divided into five groups. Inclusion criteria were: (1) hearing loss of sudden onset; (2) hearing loss of at least 30 dB at three consecutive frequencies; (3) unilateral hearing loss; (4) age above 18 years. Exclusion criteria were: (1) no follow-up audiogram; (2) bilateral hearing loss; (3) recognized alternative diagnosis such as tumor, disorder of inner ear fluids, infection or inflammation, autoimmune disease, malformation, hematological disease, dialysis-dependent renal failure, post-dural puncture syndrome, gene-related syndrome, mitochondrial disease; and (4) age below 18 years. **Results:** Complete recovery was found in 14% of patients (18/130) and marked improvement was found in 6% (8/130), giving an overall success rate of 20%. The best results were obtained in the second group (i.e. patients given intratympanic glucocorticoid + prolonged orally administered glucocorticoid) where the success rate was 28%. In general, the older the patient, the smaller the improvement in hearing, a correlation that was statistically significant. **Conclusions:** In treating SSNHL, the highest rate of hearing recovery – 28% – was in the group of patients given intratympanic corticoid plus prolonged treatment with orally administered glucocorticoid.

Effects of background noise on the encoding of speech sounds in neonates: A frequency-following response (FFR) study

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Introduction: Background noise impoverishes speech understanding in people across the life span. This difficulty can be exacerbated by developmental deficits during the first years of life and can eventually lead to language difficulties. However, the effect of background noise on speech processing during the earliest stage of life has not been investigated. The frequency-following response (FFR) is an auditory evoked potential that reflects the encoding of temporal and spectral features of speech sounds and is disrupted in a wide range of language-related disorders. **Objective:** This investigation seeks to explore the possibility of using FFR as a potential biomarker for measuring speech in noise (SIN) in babies. More specifically, the aim of this study is to document the feasibility of recording FFRs in babble noise in neonates within a maternity ward during the days immediately after birth and to compare this effect against that from a reference group of adults. **Material and methods:** FFRs were recorded to /da/ syllables in quiet and noisy background conditions, respectively, in 24 newborns and 10 adults. FFRs were recorded using click and speech /da/ stimuli in quiet and also in ipsilateral babble noise for the latter (S/N=+10). Stimuli were delivered to the right ear using a SmartEP platform including the cABR and Advanced Hearing Research modules (Intelligent Hearing Systems, Miami, Fl, EEUU). Three parameters were retrieved from the FFR in the time and frequency domains (root mean square [RMS] of the prestimulus region, signal-to-noise ratio [SNR] of the brain response, and spectral amplitude). **Results:** All analyses are performed under Matlab R2015b (Mathworks) using routines provided by Intelligent Hearing Systems (Miami, Fl, EEUU) and custom scripts developed in BrainLab. Spectral amplitudes during the consonant region revealed that background noise had a milder effect on speech processing in newborns than in adults. **Discussion:** Our findings suggest that newborns process speech presented in background noise at birth differently, possibly due to their immature auditory system which is exposed to attenuated sounds during gestation. However, we cannot disregard that the group differences in noise effects could be partially affected by intensity differences. This study constitutes the first step towards understanding the development of speech-in-noise (SIN) processing from the first days of life. An early detection of FFR abnormalities in processing SIN could lead to earlier intervention of central auditory processing disorders and language difficulties.

Effects of COVID-19 on people with hearing impairment

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Objectives: The coronavirus pandemic (COVD-19) has resulted in many rules and restrictions in the interest of public safety. In the present study, we sought to follow-up and expand on the study by Naylor et al. (2020), by examining the impact of COVID-19 on hearing impaired people living in the greater Copenhagen area, Denmark (DK) and the greater Chicago area, United States (USA) during February 2021, when COVID-19 infection rates and restrictions were at their peak. **Material:** The survey design was guided by previous COVID-19 and hearing loss surveys (Saunders et al., 2020, Naylor et al., 2020). It was revised and updated using a fast iterative process as survey results were time sensitive. The final survey contained 24 questions. Eighteen were

fixed quantitative responses and six were open-response questions. Questions asked about self-reported hearing ability and hearing aid use, tinnitus, and the use of face masks and communication behaviors during COVID-19. The survey was administered online using SurveyMonkey®. **Methods:** Participants were recruited from the DK and USA GN Hearing test persons database. The participants in this database are volunteers, who have agreed to be contacted to participate in a variety of studies. Questions were grouped into one of five themes: hearing and hearing aids; tinnitus; behaviors; communication; and emotions. Descriptive statistics report the overall findings from the quantitative survey questions and qualitative questions were analyzed using content analysis. Open-ended questions in Danish were translated to English before they were analyzed. Next, subgroup comparisons were examined for hearing status, region, and age. For hearing status, participants were divided into better hearing (BH) and worse hearing (WH) subgroups based on self-rated hearing ability. For region, DK responses were compared to USA responses. For age, participants under 80 years were compared to participants 80 and over. **Results:** In total, 294 people responded to the survey giving an overall response rate of 56.7%. Participants' ages ranged from 28 to 95 years (*M*=71 years). Dividing participants in to hearing status subgroups, 78% are in the worse hearing (WH) group and 22% are in the better hearing (BH) group. 94% of participants reported wearing hearing aid/s. 79% reported using hearing aids >8 hours per day and 77% reported wearing hearing aids as much as before COVID-19. 84% agreed that it was always or sometimes difficult to understand when communicating with a person wearing a mask, primarily citing lack of lip reading and facial expressions and distortion of sound as the reason. WH group reported significantly more than BH group difficulties understanding speech when speaker was wearing a mask, that they worry about communicating with someone wearing a mask and that they are relived not having to attend social events where they might hear poorly. Some significant differences between regions were also seen. Ownership of hearing aids was significantly higher in DK than USA, even though the difference in self-reported hearing was not significantly different between the two regions. Significantly more people in USA report daily conversations with masked persons and also report an increase in use of video calls since COVID-19. **Conclusions:** Self-reported hearing loss was the dominant driver of differences seen in the current study. People with WH had a different experience with COVID-19 than people with BH. WH reported greater difficulty understanding speakers wearing masks and more anxiety. WH people were also less likely to report reduced hearing aid use time during COVID-19. Many people, also with self-reported BH, have difficulties understanding speech, when the speaker is wearing a mask. This indicates that it is very important to be mindful of good communication strategies when speaking wearing a mask.

Efficacy of a Free App for Testing the Hearing Sensitivity of Young and Middle-Aged Adults

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Introduction: Untreated hearing loss often compromises an individual's communication abilities, psychophysical health, and quality of life. As detection is the first step to intervention, it is essential to identify individuals with hearing loss so that they can seek intervention. Traditionally, detecting hearing loss requires well-trained audiology professionals and audiometers, which might be scarce in some countries. Recent technology advancement made automated hearing test possible and they can be administered by non-audiology professionals. While many hearing screening apps are commercially available, most of them requires either subscription or license fees. We have developed an automated hearing test app (Aud•It) and examined the feasibility of the app for testing young and middle-aged adults. **Methods:** The Aud•It audiometry app uses a 3-alternative force-choice psychometric paradigm to reduce the false-positive rates (i.e., 33.3%). During the test, the participants were shown two geometric shapes, each of which flashes 3 times during a trial but only one is presented with synchronized pulsed tones. The participants were instructed to tap the shape that is associated with the pulsed tones. If they did not hear any tones, they would tap the button named "No Sound." Additionally, "No Sound" trials in which no sound stimulus was presented, were added to Aud•It as indications of participants' understanding of the test tasks and test reliability (i.e., if the participant chose a shape during a "No Sound" trial, they either did not understand the test task and need reinstruction or they are unreliable in their responses). Aud•It can test hearing thresholds between 15 and 100 dB HL from 250–4000 Hz and between 15 and 90 dB HL from 6000–8000 Hz. Thresholds lower than 15 dB HL was recorded as 15 dB HL. Each frequency has its unique geometric shape to cue the participant to listen to tones with different pitches. Twenty young adults age between 18–44 years and 29 middle-aged adults age between 45–64 years were recruited to participate in the study. Their cognitive function was tested using Minimental State Evaluation (MMSE). Otoscopy, tympanometry, and distortion product otoacoustic emissions were carried out to detect any disorders in their outer and middle ear. Participants' hearing thresholds from 250–8000 Hz were tested using conventional air conduction audiometry and using Aud•It in a regular office (i.e., 6 frequencies ×2 ears=12 thresholds per participant). During the conventional audiometry, half of the participants raised their hands and the other half pressed a button when they heard pulsed tones because these are the most common response modes. Before testing all the frequencies in the Aud•It audiometry, each participant was given a practice session using 1000 Hz tones. The order of testing for conventional and Aud•It audiometry were counterbalanced and the examiners were blinded to the hearing thresholds obtained using the two audiometry. **Results:** All participants had MMSE scores within normal limits. When their hearing thresholds obtained using Aud•It and conventional audiometry were compared, 94.7% were within ±5dB for young adults and 96.2% for middle-aged adults. When the hearing threshold criterion of field testing is used, 98.7% of the thresholds agreed within ±10 dB for young adults and 98.2% for middle-aged adults. Further, 17 of the 20 young adults and 20 of the 28 middle-aged adults expressed a preference of Aud•It over conventional audiometry. **Conclusions:** Aud•It can serve as an effective and preferred alternative to conventional audiometry for mass hearing screening of young and middle-aged adults.

EMA – method, experiences, potentials, and challenges

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Objectives: In audiology, questionnaires are used to address the subjective perspective on hearing abilities and hearing aid benefit. Weaknesses of this approach, e.g., memory bias and possible mismatch of the pre-defined and individually experienced listening situations, are overcome by EMA. This method includes ad-hoc query with prompt and repeated assessments in real-life as well as data collection of objective environmental characteristics. **Material:** An EMA system was developed including one microphone on each side of the head and wireless data transmission to a smartphone. An app on the smartphone analyzes objective data and manages queries which are repeatedly presented to the EMA user. **Methods:** The audio signals recorded by the two microphones are analyzed in segments and deleted immediately thereafter. By storing only averaged characteristics of the environment's acoustical properties, the privacy of the user and bystanders is fully preserved. Further offline analysis allows for own-voice detection and background estimation. The user survey is carried out using an adaptive questionnaire that allows for specifying situations and sound sources as well as for assessing various aspects like speech understanding, loudness, and listening effort. In a field study, first-time and follow-up hearing aid wearers used the EMA system for 3–4 full days before hearing aid fitting and after hearing aid acclimatization. **Results:** EMA provides snapshots of individual listening experiences affected by hearing loss, living environment and life-style. Despite spending most of their time at home, the participants' EMA profiles show considerable inter-individual variability both in the type of listening events assessed and hearing aid benefit. In this regard, EMA uncovers individual differences and hearing-related needs. However, this highly differentiated surveying also reveals its downside, particularly when aiming at a comparison of subjective assessments, e.g., before and after hearing aid uptake. Since everyday life may be similar but never the same, the intra-individual match even for aggregated listening events was only moderate before and after intervention. As a consequence, the fragmentation of data and the variety of real-life assessments reduce the ability to draw conclusions based on quantitative approaches. Considering the objective features that hallmark the acoustic conditions, i.e., the attempt to control retrospectively for parameters like RMS level or signal-to-noise ratio estimates, relates EMA to conventional variables in lab experiments and improves the interpretability of subjective assessments. Advanced processing techniques can tackle this issue to a certain extent but will hardly resolve it completely. Thus, designing an EMA field study in hearing rehabilitation is about balancing out dilemmas: e.g., highly specific and, consequently, fragmented survey data versus lack of differentiation; repeated assessments to achieve a somehow holistic picture versus overloading the user and possible reactivity on the measure; transparent acoustical information versus privacy. This contribution shows results from a field study conducted with adults who were inexperienced in hearing testing beyond the regular ENT protocol. It points out pitfalls and opportunities that can arise when linking EMA to standard audiometric diagnostics. **Conclusions:** EMA gives new insights into the hearing-related quality of life on an individual basis. The method has advantages but bears challenges in terms of user's burden, hard- and software development, data analysis, and privacy issues.

Evaluating the Effectiveness of Asymmetrical Directionality with Bimodal Systems

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Introduction: Research supports that bimodal stimulation includes improvements in auditory performance and daily living over using a cochlear implant or hearing aid alone. Bimodal users report improvements in speech perception compared to using a cochlear implant alone and strong preference for bimodal stimulation when listening in quiet or noisy environments, for environmental awareness and when listening to music 1–4. Although bimodal users continue to achieve high levels of satisfaction, speech perception in noise is problematic. The aim of this lab and field study is to identify which directionality schemes in a bimodal solution are preferred using an ecological momentary assessment tool and lab testing. The benefits of acoustic and electrical stimulation are shown across multiple domains. While approaches to the measurement of benefit typically use clinical or laboratory-based measures with a focus on benefit in terms of hearing performance, other domains are psycho-social and should be investigated. It is critical to analyze subjective and real-world outcome measures in the development and implementation of effective audiological treatment and rehabilitation. For researchers and audiologists, it is imperative to consider other domains and identify factors that cause bimodal users to be satisfied or dissatisfied with their hearing devices, in their natural environments. Using an EMA tool allows a modern idiographic, real-time approach that tracks users' behavior, emotion and experiences toward their hearing aids and cochlear implants in ecologically valid conditions. A collection of these repeated assessments will quantify self-reported benefit without subjecting data to recall bias. The objective of this trial is to evaluate asymmetrical directionality in bimodal users for hearing speech in noise and in daily life. The aim is to collect information and data so that improvements and updates to guidance material for clinicians to better control a more positive outcome particularly in noisy environments for bimodal patients can be offered. **Material and methods:** In this observational study, subjects are fit with Cochlear Kanso 2 or N7 sound processor on the implanted ear and ReSound ONE on the contralateral ear. During visit 1, recorded speech recognition scores using AZ Sentence test in quiet and noise are obtained in a laboratory setting, in the following conditions: 1) Cochlear implant alone, 2) Cochlear implant + hearing aid in a defaulted program, and 3) Cochlear implant + hearing aid in directional program. Patient reported outcomes using Speech Spatial and Qualities of Hearing (SSQ-12) are administered, and an EMA mobile app called RealLife Exp is used to capture daily use for one week. A collection of repeated assessments will help quantify self-reported benefit without subjecting data to recall bias. The patient reported outcomes, as well as speech recognition in quiet and noise are compared to subject performance gathered during Visit 2, to demonstrate the effectiveness of bimodal fitting. **Results:** Preliminary results are trending in a positive direction at the date of this submission.

Trending suggests patient's speech recognition scores with two technologies will not be compromised and patient's self-reported outcome measures will be improved. **Conclusions:** The purposes of this study were to (a) evaluate hearing outcomes with a bimodal system for a laboratory measure and to assess the effectiveness of asymmetric directionality in the Resound One hearing aid in tandem with Forward Focus in the Nucleus 7 or Kanso 2 CI sound processor and (b) to evaluate the effectiveness of asymmetrical directionality in bimodal fittings using an ecological momentary assessment tool in a take-home trial. The data collected in this research study will allow for improved evidence based clinical guidelines when using two different types of technologies (acoustic and electric) and will be an option for improving the quality of care for individuals with bimodal systems.

Evaluating the Revised Work Rehabilitation Questionnaire in Cochlear Implant users Cochlear Implant Outcome Assessment Based on the ICF

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Objectives: The 59-item Work Rehabilitation Questionnaire (WORQ) was developed based on the International Classification of Functioning, Disability and Health (ICF) core set for vocational rehabilitation to assess work related functioning. It was revised to include 17 questions, assigned to 14 ICF categories relevant to cochlear implant (CI) users. This cross-sectional multicenter study aimed to evaluate CI users' responses on the WORQ questions to describe and generate ICF qualifiers for the revised WORQ in CI users, forming part of a broader framework of CI outcome measures linked to the ICF. **Methods:** 177 adults over the age of 18 years with a minimum of one year's device experience were included in the analysis. The WORQ was completed by the participants at a routine visit to the clinic, via email, or via post. **Results:** Most of the CI users perceived no problem on the WORQ questions (53.7–91%), finished secondary school (54.2%) or obtained a college or university degree (32.8%) and are either employed (41.2%) or retired (34.5%). CI users that are currently working mostly have a full-time position (34.5%). Subjects reported no problem (91%) with sensation of falling, while handling communication devices and techniques (10.9%) and tinnitus (9.6%) showed the highest number of subjects reporting a complete problem. **Conclusions:** Overall, most of the CI users experienced no impairment, restriction or limitation on the WORQ questions and their assigned ICF categories. Their education level resembles the education level of the general population and they seem to integrate or reintegrate well in professional life postoperatively.

Evaluation of auditory sensitivity among instrumental orchestra musicians

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Introduction: The hearing performance of professional musicians extends beyond the threshold range of standard tonal audiometry. The professional competence of musicians is based on their ability to control their hearing over the instrument and their ability to co-play. Efficient analysis of sounds across the audible range appears to be crucial in maintaining the professional performance of classical orchestral musicians. **Purpose:** The purpose of this study was to analyze audiometric testing of classical orchestra musicians. The specific objectives were to analyze the tonal audiometry studies in relation to gender, age, and type of instrument played. **Material and methods:** The study material consisted of 40 opera orchestra musicians.22 men, 18 women aged from 26 to 62 years. The subjects played violin, viola, cello, double bass, French horn, oboe, trumpet, trombone, flute, bassoon, clarinet, organ, percussion. Each subject underwent a physical otolaryngological examination followed by impedance and full frequency tonal audiometry. **Results:** The results of the study showed that 80% of the subjects had bilateral normal AT testing. The remaining subjects were observed to have mild high-frequency hearing loss in the range of 4 kHz and above. In high-frequency audiometry, only 18% of subjects had normal results.The analysis of audiogram thresholds did not show differences according to gender. A correlation with age was noted. No significant differences in audiograms were registered between musicians playing different groups of instruments. **Conclusions:** High-frequency audiometry provides an opportunity for a broad assessment of auditory function. Professional classical musicians are characterized by a better hearing sensitivity than the adult Polish population. The sound range of the instrument played does not influence the hearing condition of musicians.

Evaluation of central auditory system in young and elderly individuals

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Objectives: With aging, loss of function in the anatomical localizations of the central auditory nervous system leads to decreases in central auditory processing (CAP) functions. The aim of this study was to invastigate the temporal processing functions of the tests on the young and elderly individuals according to the anatomical localizations and to evaluate the relationship between the CAP tests of the same individuals. **Material and methods:** Twenty four individuals, 12 females and 12 males with normal hearing between 18–30 years of age and 20 individuals, 7 females and 13 males with normal hearing between

60–75 years of age were included in the study. Mental evaluation, audiological evaluation tests and central auditory processing tests were performed on individuals. In the evaluation of central auditory processing; frequency pattern test (FPT), duration pattern test (DPT), masking level difference (MLD) test, random gap detection test (RGDT) were used. Speech discrimination scores (SDS) and speech in noise (SIN) scores were analyzed in both groups. Speech tests and CAP tests were compared between the groups. The relationship between all CAP test results and the young group, the elderly group and the age was investigated. **Results:** In young and old individuals respectively; SIN scores (%88.50±6.27/%71.40±9.29), 500 MLD thresholds (11.33±1.27 dB/9.20±2.19 dB), 1000 Hz MLD thresholds (8.08 dB/5.80 dB), RGDT thresholds (1000 Hz-4.16±4.43 ms/9.45±5.11 ms), FPT scores (%89.16±5.83/%75.75±8.62) and DPT scores (%95.83±5.24/%90.00±8.58) were obtained. There was a statistically significant difference between the groups in terms of SIN, MLD, RGDT, FPT and DPT scores ($p<0.05$). No statistically significant relationship was found between the younger and older groups ($p>0.05$), but a statistically significant relationship was found between age and all CAP tests ($p<0.05$). **Conclusions:** According to the results obtained in our study, it was observed that elderly individuals had declined temporal sequencing, temporal resolution and binaural interaction skills compared to younger individuals.

Evaluation of cochlear synaptopathy in young adults occupationally exposed to noise

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Objectives: The aim of this study was to investigate the possible association between electrophysiological outcomes, speech perception in noise, as possible measures of cochlear synaptopathy, and occupational noise exposure in normal-hearing young adults. Design: Fifty young adults occupationally exposed to noise and 50 non-exposed young adults from Zhejiang province in China were selected. All participants presented with normal hearing thresholds (equal to or better than 20 dB HL) and distortion product otoacoustic emissions. Both groups of participants were evaluated with the Matrix test in Mandarin, and auditory brainstem response (ABR) with and without ipsilateral white noise. The ABR was obtained for click stimuli at 50, 60, 70, 80, and 90 dBnHL. Peak-to-trough amplitudes for I and V waves were obtained. The ABR wave I amplitude, the wave V/I amplitude ratio, and the slope of the wave I amplitude growth as a function of stimulus intensity (uV/dB) were calculated. In addition, the wave V latency shift was obtained as a function of the intensity of the white noise. Cumulative noise exposure (CNE) was obtained for noise-exposed participants. **Results:** Noise-exposed participants exhibited worse extended high-frequency thresholds and Matrix test results than control group participants. No significant differences between both groups were found for ABR measures. CNE was not significantly correlated with either of the auditory outcomes. **Conclusions:** Matrix test results and extended high-frequency thresholds significantly differed between normal-hearing young adults occupationally exposed to noise and normal-hearing young adults without occupational noise exposure. We cannot conclude that the measures used in this study can be used to detect cochlear synaptopathy in humans.

Evaluation of ECochG for the monitoring of cochlear implant electrode insertion

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Objectives: The main goal of the study was to record acousticaly evoked cochlear potentails directly from the cochlea via cochlear implant electrode. Then evaluation of ECochG as a medical test for monitoring of electrode array insertion and for evaluate of patient's residual hearing after surgery. **Material:** 12 adult patients (range 28–84 years) with various level of residual hearing confirmed in pure tone audiometry. All of patients were implanted with Advanced Bionics cochlear implant with electrodes HiResTM Ultra 3D, HiFocusTMSlimJ or HiFocusTMMidScala. In this study potentials were recorded for frequencies 250 Hz, 500 Hz, 750 Hz and 1 kHz. **Methods:** Acoustic stimulation was possible by the insert earphone placed in external ear canal and a special medical system Bionic Ear Data Collection System (BEDCS). ECochG potentials was recorded using the most apical electrode contact. The recorded signal was processed by the implant and sent via the back telemetry to the measurement PC. Measurement has start when the surgeon placed the tip of the electrode inside the cochlea and end with completed insertion of electrode. Evaluation contain also the postoperative measurements which was made with the same system during the standard clinical appointments. **Results:** Cochlear Microphonics were observed in almost everyone patients (except one subject). Results was stable in time and confirmed a presence of residual hearing in implanted ear. **Conclusions:** ECochG recording is promising way to create the new medical test for monitoring of cochlea function during electrode insertion and for evaluate of residual hearing after surgery.

Event-related potentials of single sided deaf cochlear implant users – an insight into the comprehension of speech in noise

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Objective: Speech in noise intelligibility is reliant on binaural input. In individuals with single sided deafness (SSD) – profound hearing loss in one ear and normal hearing in the contralateral

ear – binaural input is not established. A cochlear implant (CI) is the only way to establish functional hearing in the profoundly deaf ear with functional assessments highlighting the improvement in speech in noise intelligibility with the provision of a CI in SSD CI users. However, there is little research looking at how the brain integrates the electrical signal produced by the CI and the acoustic signal produced by the normal hearing ear. As such, this study aims to investigate how the provision of CI impacts speech in noise perception of SSD CI users. **Method:** High density electroencephalography (EEG) from twelve SSD-CI participants was recorded whilst they completed a semantic acoustic oddball task. All participants completed the oddball task in three different conditions: 1) with the CI-On in background noise, 2) with the CI-Off in background noise and 3) with the CI-On without background noise (control). We examined task-performance (RT, subjective listening effort and accuracy) and measured N2N4 and P3b event-related brain potentials (ERPs) linked to the detection, discrimination, and evaluation of task relevant stimuli. **Results:** Reaction time was significantly different between all three tasks with CI-Off recording the slowest and Control being the fastest. N2N4 area for CI-Off was identified to be significantly smaller when compared with the other two conditions and latency was also delayed for this condition. Despite these differences noticed in RTs and N2N4 area and latency, we observed similar results between all three conditions for P3b area and latency. This finding or albeit lack of finding is most likely attributed to a ceiling effect of the oddball task which is supported by high accuracy (>90%) observed in all three tasks. **Conclusions:** Difference in RT and N2N4 effects suggest that the provision of a CI does make it less cognitively demanding for a SSD CI user to understand speech in noise. The lack of difference between the conditions for P3b and high accuracy to target stimuli across all conditions suggest that the present auditory oddball did not place enough demand on the participant. Future studies should look to incorporate a more complex task in order to get a deeper understanding of the underlying neural processes that facilitate speech in noise intelligibility.

Evolution of Type D personality traits after cochlear implantation in adults aged 55 years and older: A longitudinal, controlled, multicenter study

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Objectives: To study the evolution of type D personality traits in older adults after cochlear implantation compared to a control group of severely hearing impaired older adults who did not receive a Cochlear Implant (CI). A secondary purpose was to assess whether the COVID-19 period influenced this evolution. Type D personality combines a high degree of negative affectivity (NA) and social inhibition (SI). **Methods:** In this prospective, longitudinal, controlled multicenter exploratory study, 76 older CI users and 21 severely hearing impaired controls without CI were included. The CI group and the control group did not differ significantly regarding age, formal education, residual hearing, DS14 total score, NA and SI at baseline. Type D personality traits were assessed with the Type D Scale-14 (DS14) at baseline (T0) and 14 months later (T14). **Results:** Type D personality traits differed significantly over time between the CI group and the control group (p<0.001). In the CI group, the DS14 total score (p<0.001), NA (p<0.001) and SI (p<0.001) improved significantly over time, while no significant difference was found in the control group. Significantly fewer subjects were categorized as Type D personalities in the CI group (p=0.023) at T14, whereas no significant change was found in the control group (p=0.250). COVID-19 did not influence the evolution of type D personality traits significantly in the CI group. **Conclusions:** Cochlear implantation has a positive effect on type D personality traits in older adults with a severe-to-profound hearing impairment.

Examining speech recognition with the use of adaptive gain receivers and ReSound Multi Microphone technology

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Objective: The benefits of hearing assistive technologies (HAT) are well documented in today's literature. They are applicable for not only children and adults with hearing loss, but also those with auditory processing deficits, learning disability, auditory neuropathy spectrum disorder, language and attention deficits, as well as English language learners and those who hear within normal limits (American Academy of Audiology, 2008). The benefits of HATs are intuitive: improvement of the Signal-to-Noise (SNR) by placing a microphone closer to the target of interest and sending that audio input directly to the user's hearing devices. This can improve the individual's speech perception and discrimination in noise, speech understanding at a distance, as well as improve performance and attention in school. The most commonly used HAT devices include frequency modulated (FM) and digitally modulated (DM) wireless remote microphone systems. The ReSound Multi Microphone is a unique wireless microphone solution that meets the needs of its users as well as offering an affordable solution for all. What makes the Multi Mic solution flexible and cost effective is its true compatibility with HATs from other industry manufacturers,

all while maintaining a proven adaptive gain advantage. This research compliments a previous investigation that examined the ReSound Multi Microphone's behavior when used in tandem with digital modulation technology. The project: An innovative and cost-effective approach to wireless remote microphones (Quilter & Wright, 2017), discussed and confirmed the preservation of the adaptive gain benefits of adaptive gain receivers when attached to a Multi Microphone. To date there is a lack of research that examines specifically, patient's speech recognition scores obtained with the use of adaptive gain receivers connected via audio shoe to hearing aids versus an adaptive gain receiver connected to the Multi Mic. The intention of this study is to explore and confirm that patient speech recognition scores obtained with the use of adaptive gain receivers connected to the Multi Microphone, remain uncompromised between the two technologies. Research objectives for this investigation include: 1. Examine speech recognition scores obtained with the use of adaptive gain receivers coupled to Multi Microphone, 2. Promote access to speech and language using cost effective measures and 3. Instill confidence in audiologists when fitting two different technologies. Secondary goals include reducing negative social impact by taking assistive technology off the ear level. **Material and methods:** In this randomized, double-blind study, 20 subjects are fit with receiver in the ear hearing aids and used the following additional equipment to carry out testing: universal adaptive gain receivers, touch screen transmitter, Multi Microphone, direct audio input shoe and remote control. Using the Danish sentence test, Dantalle II, recorded speech recognition scores in the presence of 70 dB noise are obtained in the following conditions: 1) hearing aid only, 2) adaptive gain receivers connected to the hearing aids via direct audio input, 3) adaptive gain receivers connected to the hearing aids via Multi Microphone and 4) Multi Microphone only. **Results and conclusions:** Data was analyzed using a one-way repeated measures ANOVA to identify statistical differences between conditions. Results reveal that patient's speech recognition scores with two technologies will is not compromised, and cost-effective solutions were uncovered. Conclusions indicate there are proven benefits with Multi Microphone on speech recognition in the presence of noise, preservation of the adaptive gain advantage is possible when using hearing instruments with receivers streaming through Multi Mic technology and that verification is necessary when you are mixing manufacturers technology.

Experiences of an Internet-based aural rehabilitation (IAR) program for hearing aid users: A qualitative study

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Background: Internet interventions for hearing aid (HA) users have been shown to be effective in helping persons with hearing problems. As earlier research refers to objective data on these effects, little is known about how participants experience the Internet interventions subjectively. The aim of the present study was to explore participants' experiences of an Internet-based aural rehabilitation (IAR) program for HA-users, and to explore the possible subjective benefits of such a program. **Material and methods:** A qualitative exploratory design was implemented involving semi-structured telephone interviews. The interviews were transcribed and analysed using content analysis. Interviews were conducted with 20 participants (9 men and 11 women) who had completed an IAR program for HA-users. The participants were 57–81 years old and had used HAs for 2–25 years. **Results:** The overall results indicate positive experiences of the IAR program, and an overreaching theme of increased self-esteem was identified. The results are organised in three (1–3) main categories: 1. General experiences associated with participating in the program, 2. Knowledge obtained from the program, and 3. Perceived impact of taking part in the program. Many participants described the program as a source of knowledge with positive effects on their self-esteem. These positive effects triggered participants to apply gained or revisited knowledge practically in everyday life. However, a majority of the participants did not report increased HA-use, in terms of hours per day, rather they reported increased confidence in how to deploy new or revisited knowledge practically related to their everyday HA-use. **Conclusions:** The program underlines the ability of HA-users having confidence in how to deploy new or recognised knowledge practically, i.e. enhancing empowerment, and shows the participants what they can do rather than what they cannot do. In conclusion, our recommendation for future efforts when developing and modifying Internet interventions is that theory and practice must go hand in hand.

Expert subjective assessment of singing in children who use cochlear implants

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Background: Cochlear implant (CI) users are often described as having poorer music perception skills than peers with normal-hearing. Singing is an activity which relies on hearing one's own voice well to modulate the pitch and amplitude with accuracy. Musical appreciation and assessment is largely a subjective exercise. However, when critiquing a musical performance, a trained expert will be best placed to give valid subjective feedback which is based on experience and expertise. **Objective:** This study sought to quantify the strengths

and challenges for singing by a small group of children who use CIs and assess their capacity to perceive deficits in their singing skills. Their ability to learn to modify their own singing production was also assessed. **Material:** A pilot choral program was developed through a collaboration between SCIC Cochlear Implant Program – an RIDBC Service and Sydney Children's Choir to bring together experts CI services and children's choral training. A group of six children aged 8–10 yrs who use CIs volunteered for the two-day program. The participants had a variety of hearing loss and device configurations including bilateral CIs and one child with single-sided deafness with a CI. **Methods:** The children engaged in a series of choral activities including individual assessments with a professional conductor as well as choral singing. The choral singing activities initially involved the small group of CI users alone. The children were then integrated into an existing children's choir where they were paired with buddies who had typical hearing. Individual choristers, their buddies and the professional conductor all completed questionnaires and feedback forms to record various aspects of their experience. Audiological data for the children with CIs was reviewed to investigate any potential correlations with singing accuracy. **Results:** Subjective Assessment of Singing Ability – Vocal pitch matching was identified as the area of greatest challenge for the subjects with 67% of the group identified as having significantly poorer vocal intonation than would be seen in children with typical hearing who volunteer for a choral program. Two of the six participants had difficulty in modulating their voice to the correct range to sing higher notes. Overall, the children performed most accurately on rhythm tasks with the conductor rating 67% as performing in line with typically-hearing choristers of the same age. Reading skills impacted on at least one child's performance. Some improvements in vocal intonation were noted over the course of the training sessions. Audiological Correlations – Hearing device configuration and residual hearing was not noted as significantly correlating to the subjects' singing accuracy in this pilot study. **Conclusions:** The children with cochlear implants in this group were most successful at matching rhythm and least successful at matching vocal pitch. However, some showed improvements in the course of the workshops. Audiological profile did not correlate significantly with their success at singing tasks.

Factors influencing mainstream or special educational placement among Polish children with cochlear implants

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Objectives: Polish Pediatric Cochlear Implant Program was established at the same time when Poland has ratified the Convention on the Rights of the Child and the new Act on the education system of September 7, 1991 entered into force. The legal basis was created and disabled children were given the right to use all forms of education and parents were given the right to choose the form of education for their own child. In Poland deaf children where typically educated in special schools. With application of cochlear implants it is possible to compensate for a hearing loss much more effectively than before thus better counteracting the negative consequences of hearing impairment. The aim of the study was to analyze educational placement settings of Polish children with cochlear implants (CI) and evaluation of factors like: age at implantation, CAP result, place of residence, mother level of education and SES which may contributes in child being mainstreamed. **Material:** The study group consisted of 105 Polish children with CI age range 11.8–14.4 who were finishing the primary education. **Method:** Survey distributed among parents regarding type of primary school child was attending, place of residence, family income and mother education level. Household's monthly income was categorized using The European Health Interview Survey (EHIS) division. For statistical analysis divided to categories: 1 – low income, 2 – middle, 3 – high. Mother educational attainment was categorized with the use of ISCED 2011 levels of education and divided into three groups 1 – finished primary education including lower secondary, 2 – upper secondary general and vocational and 3 – upper education. Full data was obtained from 105 cases (n=105). **Results:** Regular school were attended by 79 children (75%) and special education schools by 26 children (25%). Variables found to be associated with mainstream educational placement among Polish children with cochlear implants were: younger age at implantation, higher auditory performance, living in cities, higher level of maternal education and better economic status of the family. **Conclusions:** There are variables that can be control by the health system and have influence on child educational placement like: time of intervention and cochlear implantation as well as providing the child with the state of the art processor fitting procedure and focus on auditory skill development to maximize the outcome of implantation. We need to take into consideration all the variables that cannot be control by the health system and have major influence on child educational placement. The final decision regarding child school placement lies with the parents and is determined by capacity of the child to learn in a spoken language environment but can also rely on the parent's financial and personal resources. Obtained results may be taken into consideration in planning proper support for families with children with cochlear implants.

Family-Centered Early Intervention for children who are deaf or hard of hearing: An integrative review

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Objective: Over the past few decades, there has been an increasing shift towards emphasizing the importance of the child's family taking an active role in the habilitation process, through Family-Centered Early Intervention (FCEI) programs. Accordingly, the Health Professions Council of South Africa (2018) recommends that early intervention services following confirmation of hearing loss must be family-centered within a community-based model of service delivery that is culturally congruent. The aim of this study was to explore and document current evidence reflecting trends in FCEI for children who are deaf or hard of hearing (DHH) by identifying and describing current practice models or processes of FCEI for these children. **Methods:** A systematic integrative review was conducted. Sage, Science Direct, PubMed and Google Scholar

databases were searched for studies published in English between January 2009 and January 2019 reporting on family-centered early intervention programs for children who are DHH. Studies that focused on speech and language outcomes of children who are DHH, youth and adults who are DHH, education for children who are DHH, universal newborn hearing screening, professionals' roles in early hearing detection and intervention, diagnosis of hearing loss and sign language were excluded from the study. The 16 studies that were included in the integrative review included findings related to caregiver involvement, caregiver coaching/information sharing, caregiver satisfaction and challenges experienced with FCEI program. **Results:** Findings were discussed under four themes: caregiver involvement, caregiver coaching/information sharing, caregiver satisfaction, and challenges with FCEI. Generally, there is sufficient evidence for FCEI with caregivers indicating the need for full involvement in their children's care. Methods of caregiver involvement involving caregiver coaching/information sharing need to be culturally and linguistically appropriate, with sensitivities around time and manner. This increases caregiver satisfaction with intervention programs and improves outcomes for children who are deaf or hard of hearing. Challenges identified by the studies raise implications for the field of audiology as well as Departments of Health and Social Welfare. These challenges included logistical challenges; professional related challenges; and caregiver related challenges. **Conclusions:** Various aspects of FCEI have been investigated. Findings of these studies have a significant impact on establishing linguistically and culturally appropriate FCEI programs for children who are DHH within the South African context.

General state of audiology services in Cameroon. The case of the NCRPD (abbreviated in French CNRPH)

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Presentation of Cameroon: Cameroon is situated in Central Africa, at juncture of the Gulf of Guinea. It is bounded on the North by Chad, on the East by the Central Africa Republic, on the South by Congo, Gabon and Equatorial Guinea and on the West by Nigeria. Cameroon is a country with several major towns, amongst which are: Yaoundé – the political capital of the country with about one million inhabitants; Douala – which is the major economic city, has more than 2 mln inhabitants. The other main towns are Garoua, Bafoussam, Maroua, Bamenda etc. POPULATION: Cameroon has a populations of more than 25 mln inhabitants; 240 tribes which are found in three main ethnic groups: Bantus, Semi-Bantus and Sudanese. LANGUAGE: The number of national languages spoken in the country is more than 240 languages. French and English are the official languages, which are spoken by 70% and 30% of the population respectively Spanish and German are equally spoken by a few city-dwellers. RELIGION: Cameroon is a secular state. Two major religions have followers: Christianity and Islam. Animism is also widely practiced.

Presentation of the National Centre for the Rehabilitation of People with Disabilities: I work in the Cardinal Paul Emile Leger National Centre for the Rehabilitation of Persons with Disabilities, abbreviated in French (CNRPH). This Centre was established in 1971 by a Canadian born Cardinal Paul Emile Leger. It is a Public Administrative establishment with a legal personality and financial autonomy. It is placed under the technical supervisory authority of the Ministry in charge of Social Affairs and the financial authority of the Ministry of finance. Geographically the head office of this Centre is situated at the Etoug-Ebe neighborhood on the western periphery of the city of Yaoundé (the political capital of Cameroon). It covers a surface area of 9 hectares. The main mission of this Centre (CNRPH) is to implement Government policy on the Rehabilitation and conversion of persons with disabilities. The secondary missions are: providing psychosocial care to persons with disabilities and their families; providing medical care, audio phonology services to persons with disabilities; Apprenticeships: training and socio-professional integration of persons with disabilities; promotion of research to improve on rehabilitation activities; technical cooperation with other national and foreign Centres for the Rehabilitation of persons with disabilities as well as humanitarian organizations or associations; participating in activities or operation related to its missions actions that are to promote its development; the socio-economic and socio-professional integration of persons with disabilities; the target groups of the CNRPH are persons with disabilities and their families.

Overview of audiological services in Cameroon: For the past years, audiological services in Cameroon were located in specials schools (schools for the Deafs) in Cameroon. From 1990–2000, there was only one audiology center in Cameroon, situated in Douala (Centre d'Audiologie Applique). The owner who is late was Mr. Eugene Mboma penn – the first audiologist in Cameroon and for the whole Central Africa. It is only in year 2013 we saw the arrival of new center like Audition center (2013), Centre auditif de Douala (2012), and lately Audiocam (2017) and Afrique audition (2018). Most of these centers were based in Douala and Yaoundé. Among these centres only two are remaining: that's audition centre in Douala and Afrique Audition in Yaounde. We have few audiologists (hearing specialists) in Cameroon, the two centres in the ground.

Genetic background of autosomal dominant hearing loss

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Background: Hearing loss (HL) is the most common birth defect and the most prevalent sensorineural disorder. It is characterized by phenotypic and genetic heterogeneity. Autosomal dominant hearing loss (ADHL) is the second most common form of inherited HL with an onset usually after the first decade of life. It affects mainly high frequencies and progresses over time. Autosomal-dominant genes are responsible for about 20% of cases of hereditary non-syndromic deafness, with 51 different genes identified to date. **Material and methods:** In this study, 106 families with a vertical inheritance pattern of hearing impairment underwent targeted next-generation sequencing (NGS) using a cochlea-specific HL multi-gene panel. Genomic DNA was isolated from peripheral blood samples or buccal swabs of available family members. The panel contains

237 genes involved in non-syndromic and syndromic HL. Prior to NGS, environmental HL risk factors and DFNB1 locus (GJB2 and GJB6) related hearing impairment had been excluded in all probands. All selected variants were analyzed in the context of population databases and literature. Variants potentially related to ADHL were selected based on the prediction scores from computational algorithms (CADD, LRT, FATHHM, MutationTaster, PolyPhen-2, SIFT). Presence of the selected probably pathogenic variants and their segregation with HL within the family were confirmed by a standard Sanger sequencing. **Results:** Genetic cause of ADHL was identified in 43.4% (46/106) of the examined families. While in 56.6% (60/106) of the probands no HL pathogenic variant was found. Among the 46 identified HL variants only 26% (12/46) have been previously reported and the remaining 74% are novel (34/46). We identified missense variants (27/46; 58.7%), splice site variant (9/46; 19.5%), stop-gain variants (5/46; 10.9%) as well as frameshift (5/46; 10.9%). Among the most common causative genes were MYO6 (*n*=8), TBC1D24 (*n*=5), KCNQ4 (*n*=4), GSDME (*n*=4), POU4F3 (*n*=4) and WFS1 (*n*=4). Pathogenic variants causative of HL in the SLC44A4, NLRP3, LMX1A, FGFR3, CD164, GRHL2, TMC1, COCH, ATP2B2 and CEACAM16 genes were detected in single families. **Conclusions:** Our custom panel has demonstrated good diagnostic performance. Despite considerable advances in the discovery of HL genes, identification of causative genes still entails difficulties because of the genetic heterogeneity of deafness. Considering frequent identification of novel genetic variants it is necessary to perform thorough clinical examination and variant segregation analysis with ADHL in all available family members. In the largest families without genetic diagnosis of HL linkage analysis and whole genome sequencing will be performed. There is also a need to re-analyze the obtained results in terms of possible presence of copy number variants that might be responsible for the development of HL in the studied families.

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Genetic heterogeneity of hearing loss causes in cochlear-implanted children

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Objectives: Hearing loss (HL) is one of the most common sensory disorders that affects almost 466 mln people worldwide. Each year, approximately 1–6 out of every 1000 children are born with severe to profound HL. In the majority of deaf children HL is genetically determined and usually two pathogenic variants are detected in the GJB2/GJB6 genes (DFNB1 locus). The aim of the study was to dissect the genetic background of non-DFNB1 HL in CI patients. **Material:** The study group (*n*=51) was recruited from patients with isolated profound prelingual deafness who received CI before the age of 24 months. All patients were negative for DFNB1 locus pathogenic variants and had no environmental HL risk factors. Detailed medical history including temporal bone imaging data was analyzed. **Methods:** Genomic DNA was isolated from blood samples of deaf probands and available family members. In 51 patients whole exome sequencing (WES) was performed. After bioinformatics analysis, all pathogenic and probably pathogenic variants involved in HL development were selected based on their population frequencies (<1%), functional consequences (e.g.: missense, frameshift, splice-site) and pathogenic predictions (CADD, LRT, FATHHM, MutationTaster, PolyPhen-2, SIFT). Validation of selected variants and family segregation analysis were performed using standard Sanger sequencing. Identified copy number variants were additionally examined with array comparative genomic hybridization (aCGH) and qPCR. **Results:** Causative variants were identified in almost 73% of patients (37/51). The majority of them are localized in the MYO15A (*n*=7) and PAX3 (*n*=5) genes. Among the detected genetic variants, 26% (14/54) were inherited in an autosomal dominant manner and as many as eight of them occurred de novo. A syndromic form of HL was diagnosed in 25% (13/51) of patients. More than half (28/54) of the identified HL causative variants have not been associated with HL before. Genes for which pathogenic variants have been detected are expressed primarily in the cochlea; their main role is to maintain the proper function of the hair cells, supporting cells and stria vascularis. **Conclusions:** Obtained results show a high heterogeneity of genetic HL causes in the population of Polish DFNB1-negative cochlear-implanted patients. All tested children were good candidates for CI as their HL causative genetic variants are localized in genes preferentially expressed in the cochlea. In a group of patients without an identified genetic cause, the tested area should be expanded and more advanced technologies enabling full genome analysis (WGS) should be used.

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Genetic variation in STRC as a major contributor to development of mild-to-moderate hearing loss

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Objectives: STRC is commonly associated with mild-to-moderate HL, and it is frequently part of a large deletion within chromosome 15q15.3 at the DFNB16 locus. Among individuals with deafness, STRC deletions are detected in more than 1% of cases but there is a limited number of studies on STRC variation. **Material:** For this project we recruited patients with mild-to-moderate HL (*n*=200) based on the analysis of pure tone audiometry results, who were lacking HL environmental risk factors and pathogenic variants in the DFNB1 locus (GJB2 and GJB6 genes). **Methods:** DNA was extracted from blood samples using a standard salting-out method. Afterwards each sample was tested against the CNVs presence in the STRC gene using the Quantitative Fluorescence-Polymerase Chain Reaction (QF-PCR) method with specifically designed primers flanking the desired region of the STRC gene as well as its challenging pseudogene. In the next step the DNA samples were tested with multiplex-ligation probe amplification (MLPA) in order to validate the results and check the QF-PCR accuracy by using an independent method. **Results:** The STRC gene mutation profile will be presented and the contribution of STRC gene variants to the development of mild-to-moderate

hearing loss will be estimated. **Conclusions:** Variants in STRC are frequently found in patients with mild-to-moderate HL. That makes STRC a matter of concern when deliberating over major causes of this type of HL. Further research concerning STRC point mutations in gene is needed to get a better insight into the spectrum of its pathogenic variants.

Gentamicin-induced hair cell death in zebrafish – preliminary studies on the development of zebrafish model for hearing loss

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Objectives: In the hearing science, zebrafish has been long appreciated as a model organism to study ear development and function as well as the diverse effects induced by different ototoxic compounds. In zebrafish larvae, sensory hair cells are grouped into structures called neuromasts and located on the fish body surface, which makes them easily accessible for observation and manipulation. Neuromasts resemble in structure and function the sensory patches of the human inner ear. Studies on zebrafish morphology and behaviour help to asses ototoxic effects and reveal mechanism leading to hearing loss (HL) after administration of ototoxic drugs in humans. **Aim:** The aim of the study was to prepare a referent zebrafish HL model using a well-known highly ototoxic drug – gentamicin (GNT) to cause GNT-induced hair cell death in the zebrafish lateral line as a representative model for the latter studies on HL in zebrafish. The study aimed to asses hearing defects by (i) evaluating the morphology of zebrafish auditory system by dimensional measurements of the inner ear structures; (ii) applying imaging techniques to asses structure and function of neuromasts – small sensory patches containing hair cells, using a different vital dyes; (iii) use of behavioral studies for testing hearing responses – different types of movements and reactions dependent on function of the hearing apparatus. **Material and methods:** To induce damage of neuromast sensory hair cells, 5 dpf (days post-fertilization) zebrafish larvae were incubated in embryo medium containing GNT for 6 h at a range of concentrations from 50 to 400 μM. After the treatment larvae were subjected for neuromast live cell staining with DASPEI and Yo-Pro1 dyes (Thermo Fisher Scientific, Massachusetts, USA). Neuromast imaging was performed using fluorescence stereomicroscopy and confocal microscopy. Locomotor activity of zebrafish larvae after GNT administration was measured with the ZebraBox System (ViewPoint, Civrieux, France) using tracking mode before and after acoustic stimulus. **Results:** In 5 dpf zebrafish larvae treated with GNT, vital dyes' fluorescent signals were gradually lost in neuromasts in a dose-dependent manner indicating a GNT-induced cell death. All GNT-treated groups showed a statistically significant reduction in locomotor activity also indicating a lower sensitivity to acoustic stimuli. The obtained phenotype was assessed to be related to GNT ototoxicity and a consequent hearing loss in zebrafish larvae. Conclusions: The developed GNT-induced HL model showed a range of features related to disrupted sound processing mechanisms and structures in zebrafish. The prepared model can be used in a subsequent analyses of HL mechanisms in zebrafish and in further studies on the GNT-induced HL in humans.

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Ginkgo biloba extract EGb 761® in patients with chronic tinnitus: Treatment effects and effect modifiers

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Objectives: Ginkgo biloba special extract EGb 761® showed beneficial effects in the treatment of tinnitus in randomized, placebo-controlled trials. In the present trial we explored whether aetiology, risk factors, chronicity or characteristics of tinnitus, or concomitant pathologies are effect modifiers. **Material and methods:** Patients (n=170, mean age 51.6 years, 36.5% female) with chronic tinnitus (grade 2 or 3 according to Biesinger) were enrolled, treated with daily doses of 240 mg EGb 761® for a period of 24 weeks in an open-label clinical trial. Treatment effects, assessed by the Tinnitus Questionnaire (TQ), Tinnitus Handicap Inventory (THI) and 11-Point Box Scales for loudness and annoyance, were analyzed for the full analysis set (FAS) and subgroups with and without potential effect modifiers, using analysis of covariance (ANCOVA) models. **Results:** Significant improvements in all tinnitus-related outcomes were found for the FAS: pre-post differences (means, standard deviations) were 6.0±11.9 for the TQ, 7.7±17.3 for the THI, 0.8±1.9 for tinnitus loudness and 0.9±2.0 for annoyance by tinnitus ($p<0.0001$ for all comparisons). Patients with idiopathic tinnitus and those with elevated stress levels at baseline improved significantly more in tinnitus loudness and annoyance ($p<0.05$ for both) than patients with other forms of tinnitus or those with low stress levels. Treatment effects of EGb 761® were more pronounced for patients with at least syndrome level depression. **Conclusions:** EGb 761® significantly improved tinnitus-related suffering in patients with chronic tinnitus. Aetiology, stress level and depression were effect modifiers.

Health-related quality of life, in subjective, chronic tinnitus patients: A systematic review

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Background: Tinnitus is an auditory phantom sensation without the presence of an external sound source. Approximately 10–15% of the adult world population suffers from tinnitus,

making it a highly prevalent symptom. The clinical origin and representation are extremely heterogenous. While some are not troubled by tinnitus, others experience it as debilitating. This is possibly due to other associated biopsychosocial complaints and comorbidities, such as elevated stress, hearing problems, hyperacusis, cognitive difficulties, sleep disturbances, anxiety and depression, that might further burden the health-related quality of life (HRQOL) of tinnitus patients by affecting the severity or tolerance of tinnitus. **Objective:** This review aims to assess whether the presence of tinnitus is negatively correlated with HRQOL evaluated by self-report questionnaires or whether results on these questionnaires are significantly different for patients with tinnitus in comparison to subjects without tinnitus. **Method:** This systematic review adheres to the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines (PRISMA guidelines). The following databases were consulted: PubMed (National Center for Biotechnology Information), ScienceDirect, Cochrane Library, Web Of Science, and Embase (OVID). The search queries consisted of the terms tinnitus and HRQOL and their synonyms and the eligible questionnaires: EQ-5D-3L, HUI3, SF-8 and SF-36. **Results:** In first instance, 777 possibly relevant search results were found. In total, 99 duplicates were removed before the primary screening was fulfilled for the remaining 678 articles. Based upon this screening on the title and abstract, 654 articles were excluded. The remaining 24 articles were screened on full text. Ten studies were considered eligible. Half of them found a significant negative correlation between the severity of tinnitus and EQ-5D-3L, HUI3, SF-8 and SF-36. The other half of the studies concluded that, in general, patients with tinnitus scored significantly lower for these HRQOL-questionnaires in comparison to subjects without tinnitus. **Conclusions:** The assessment of the current literature led to the following conclusions. First of all, a negative correlation between tinnitus and HRQOL, as measured by self-report questionnaires, is present. Secondly, the general scores on HRQOL questionnaires are lower for tinnitus patients in comparison to subjects without tinnitus. The heterogeneity in outcome measures causes a lack of comparability of results. This forms an important point of interest for future research.

Healthy aging in elderly cochlear implant recipients: A multinational observational study

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Objectives: Hearing loss greatly affects quality of life in the elderly population. It is understood that hearing loss may have a cascading effect and interact negatively with physical, cognitive and psychosocial conditions. The primary focus of this study is therefore to evaluate the change in health-related quality of life following cochlear implant (CI) treatment in the elderly. For the secondary objective, it utilizes a full array of assessments to evaluate the impact of CI treatment on healthy aging, including its physical, cognitive and psychosocial domains. **Material and methods:** The study is designed as a multinational, multicentre prospective study in a large cohort of elderly individuals with equivalent CI experience. 100 first-time unilateral CI recipients at 60 years or above are examined on the full array of evaluations from preimplant to postimplant conditions, i.e. at 12 and 18 months after surgery. The primary indicator of changes in overall quality of life is the Health Utilities Index Mark 3 (HUI-3), whereas the other evaluations consist of details collected through case history and interview questionnaires by clinicians, data logging, self-report questionnaires completed by the recipients and a series of commonly used audiometric measures and geriatric assessment tools. **Results:** This presentation will describe how these evaluations cover the different domains of healthy aging and will characterize the preoperative condition of the study population. Results will be presented at the time of the conference. **Conclusions:** The outcomes of this study have the potential to provide crucial clinical evidence on the improvement of overall health status in the elderly through CI implantation and its associated cost savings from a payer and societal perspective.

Hearing Aid Use and Efficiency in the Turkish Geriatric Population

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Introduction: Hearing loss is a major public health problem in the world. In general, 10% of the population has a hearing loss that is high enough to disrupt communication. This rate rises to 40% in the population over 65 years of age. Presbiacusia is the major cause of hearing loss in individuals over 65 years of age. Presbycusis is a sensorineural hearing loss and the hearing aid is very important in the rehabilitation of patients with sensorineural hearing loss. This study aims to determine the rate of hearing aid use and efficiency in the geriatric population of Turkey. **Material and methods:** This is a retrospective study. Therefore, hearing aid information was obtained from audiogram data if it exists. PTA (between 500–4000 Hz), SDS, SRT values and hearing aid usage data were gathered from 3127 patients who applied to the hospital and complied to the inclusion criteria. In addition, the SRT values and SDS percentages of 332 individuals using hearing aids in this patient group were included in the study. The participants were divided into 6 groups (59–65, 65–70, 70–75, 75–80, 80–85, and 85+) according to their age. Changes in the SRT and SDS values of these groups after using hearing aids were statistically determined. **Results:** For all age groups, the number of people in need of hearing aids and the number of people using hearing aids were determined. On average,

71.22% of all individuals included in the study needed hearing aids, however only 10.6% used hearing aids. A statistical significance was observed between SRT values before hearing aid use and SRT values after hearing aid use for each group. Similarly, a statistically significant difference was observed between the percentages of SDS before and after the use of hearing aids for each group ($p<0.01$). However, the improvement in SRT and SDS values were not found as expected. The mean SRT value was found as 68 dB without hearing aid and 45.75 with hearing aid for the sixth group. When SDS values with and without hearing aids were compared for all age groups, SDS values did not exceed 76% in any group. **Conclusions:** Hearing aid usage rates of the same age groups are similar to reported values in the literature. However, this rate is quite low compared to the need for hearing aids in the geriatric population. After the use of the hearing aid, SRT levels decreased and SDS percentages increased. However, the best SRT value was found as 38.55 dB which is higher than normal values. Failure to use hearing aids in patients who need to wear hearing aids may cause hearing loss to progress and impair daily communication. Therefore, hearing aid awareness and finding the suitable hearing aid are important in the rehabilitation of the geriatric population.

Hearing and cognitive outcomes of cochlear implantation in the elderly patients

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Objectives: Hearing loss and dementia are two of the most prominent challenges for nowaday medicine. Our work based on evidence base medicine publications and clinical cases from World Hearing Centre in Warsaw. We were initially assumed that there is a correlation between cochlear implantation and cognitive functions in elderly patients and patients suffering from neurodegenerative diseases. The aim of our study was to analyze the group of patients diagnosed and treated in World Hearing Centre, in Institute of Physiology and Pathology of Hearing with the evaluation of correlation between cochlear implantation and cognitive functions. **Material:** Our study based on searching MEDLINE (PubMed), Cochrane Library and Nowa Audiofonologia. We analyzed a group of patients with post-lingual hearing loss above 65 years old and two clinical cases of patients with neurodegenerative diseases below 50 years old. All participants were examined during 2-years rehabilitation period in the 1, 5, 9, 14 and 24 months after cochlear implantation. **Methods:** Review of the existing literature on the cognitive outcomes of cochlear implantation in older adults. Assessment results of cognitive tests, speech audiometry before and after cochlear implantation, psychological and speech therapy in group of patients diagnosted and treated in WHC in Warsaw. **Results:** According to some studies, cochlear implants users and their peers with normal hearing generally showed equivalent cognitive abilities. It seems that cochlear implantation may slow down the cognitive dysfunction associated with age and neurodegenerative diseases. However given the improvement of hearing abilities after cochlear implantation that is connecting with increase in performance on cognitive test may rather be effected the improvement of hearing not increase in cognition. The majority of the work on this issue involves elders without diagnosed neurodegenerative syndromes. The own material is subject to further analysis and will be presented in the near future. **Conclusions:** Hearing loss is the third most prevalent chronic condition faced by older adults and has been connected with difficulties in speech understanding, activities of daily living and social interaction. Recent studies have suggested a correlation between severity of hearing loss and an individual's cognitive function; however, a causative link has yet to be established. Further research is needed to determine the impact of hearing rehabilitation on cognitive decline. The variety of clinical symptoms, degrees of damage to the central nervous system and the dynamics of progression in neurodegenerative diseases have made difficulty to evaluate the influence of cochlear implantation on cognitive functions and require further analysis.

Hearing health – the evaluation of an online hearing loss prevention program

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Background: The accessibility of leisure sounds and music is representative of the time we live in. Unhealthy listening habits are common. Most individuals are aware of the potential risks of their habits, but many still actively chooses to expose themselves to unnecessary risk. WHO sounds the alarm by reporting that a billion people are at risk of being affected of hearing loss due to unhealthy listening habits by 2050. They recommend measures to be put in place, such as hearing loss prevention and screening, to identify individuals with unhealthy listening habits and offer rehabilitative measures at an early stage. Earlier studies confirms that digital prevention programs can be effective in influencing perceived knowledge and listening habits of the participants. Motivation, empowerment and self-efficacy are a few of the important course components that can contribute to a healthier hearing among the participants. The need to proactively promote hearing prevention and raise awareness of the implications of not protecting one's hearing, regardless of age and hearing status needs to be addressed. With this in mind, an online hearing loss prevention program was created by the research group. The program consists of text-based information, pictures and videos, quizzes and reflective tasks, all focusing on sustaining healthy hearing. **Objectives:** The objective of the present study was to evaluate an online hearing loss prevention program to examine its potential of influencing participants perceived knowledge and listening habits. **Material:** Hearing Health, which is the name of the digital program, consist of four major themes carried out over the period of four weeks, with one theme per week. The themes are "Anatomy and Physiology", "Sound, noise and hearing protection", "Hearing symptoms" including information on tinnitus and hyperacusis, and "Rules, noise limits and recommendations". Hearing Health uses a well-known

national health care platform which allows easy access and communication between the participants and program administrator. **Methods:** Two sample groups were recruited. The first from a health care provider, recruiting individuals who recently had undergone audiological rehabilitation, and the second group from the public through social media platforms and the county official website. After initial registration and having given consent, the participants got access to the program. Using pre- and post-participation questionnaires regarding listening habits, attitudes toward noise and an evaluation form after the program addressing perceived impact on knowledge, the course was evaluated. The participants also gave consent to a 6- and 12-month follow-up to assess long term perspectives. **Results:** The results indicate that a hearing loss prevention course of this type can be used to influence listening habits and attitude towards noise. Preliminary results will be presented. **Conclusions:** Digital accessibility offers great opportunities to create hearing loss prevention courses online, accessing large groups of people in a cost-effective way. By using different modalities in the course material, and including important components such as motivation and empowerment, online hearing loss prevention courses can be an effective tool in our struggle to minimize the damage of everyday leisure noise.

Hearing loss in children with congenital cytomegalovirus infection

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Introduction: The problem of congenital cytomegalovirus (CMV) infection becomes more and more relevant nowadays. One of the most common congenital CMV complications is sensorineural hearing loss (SNHL). In addition congenital CMV infection remains a leading cause of late-onset and progressive hearing loss in children. An absence of definite audiological follow-up algorithm makes difficult the early diagnosis of SNHL even in the case of timely verification of congenital CMV infection. It leads to delayed intervention and can negatively impact child's language development. The aim is to investigate clinical profile of hearing loss in children with congenital CMV infection and to develop the audiological follow-up algorithm for these children. **Material and methods:** 60 children of the age ranged from 1 month to 5 years old with verified congenital CMV infection were involved into audiological follow-up. The control group included 61 infants of the same age with risk factors for SNHL, excluding congenital CMV infection (verified by negative PCR results). The following SNHL risk factors were taken into consideration: complications during pregnancy, prematurity, low birth weight, low APGAR score, neonatal jaundice, treatment regimen (ototoxic drugs), birth asphyxia, etc. The follow-up duration was 4 years. Audiological methods included recording of transient evoked and distortion product otoacoustic emissions, impedancemetry, registration of auditory brainstem response, auditory steady-state response and pure tone audiometry (visual reinforcement audiometry, play audiometry, conventional audiometry depending on child's age and development). Tests for auditory processing disorders (APD) consisted of speech audiometry in quiet and noise, dichotic digital test. The audiological examination was performed every 1–3 months at the age 0–12 months; every 4–6 months at the age 12–36 months; twice a year for children from 3 to 5 years old. APD tests have been performed in children elder than 4 years old. **Results:** The prevalence of SNHL was significantly higher in children with CMV infection (16.7%) than in the control group (4.9%). The degree of hearing loss varied from mild to moderate, there were 2 cases of uni- and 8 cases of bilateral SNHL. Delayed-onset hearing loss was diagnosed in 5% of all children with congenital CMV infection (in 3 of 10 children with SNHL). Time of onset of SNHL is the most probable during first three years of life. Tests for APD have been performed in 10 children with normal hearing level of both groups. 7 children of the main group and only 1 child of the control one failed the tests. So APD were suspected significantly more frequently in children with congenital CMV infection in comparison with the control group (70% and 10% respectively). **Conclusions:** Congenital CMV infection affects both peripheral and central parts of auditory pathways and may lead to SNHL and APD occurrence, thus long-term audiological evaluation is strictly recommended in this group of patients. The audiological examination has to be conducted: every 3 month during the first year of life; every 6 months at the second year and the third year of life; once a year later till 6 years old. This algorithm is a common recommendation and needs to be adapted individually for each child. The recommended APD test battery is appropriate for children elder 4 years old and has to be included into a protocol of examination in children with congenital CMV infection.

Hearing loss in Turner syndrome

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Introduction: Turner syndrome (TS) is a genetically determined congenital malformation syndrome, caused by complete or partial lack of the X chromosome. It is primarily characterized by short stature, gonadal dysgenesis and various types of dysmorphia. Craniofacial anomalies can cause deformities and dysfunctions of the Eustachian tubes, which is associated with the development of chronic otitis media. Hearing loss is common in patients with TS, both conductive, mixed and sensorineural. **Objectives:** the aim of the study was to report audiologic characteristics in a group of patients with TS. **Material and methods:** retrospective review of 69 patients with TS at World Hearing Center. **Results:** 52 patients (75%) demonstrated hearing loss, 46 (67%) bilateral. Sensorineural hearing loss dominated. Most of our patients had history of middle ear diseases. 55 patients (80%) underwent surgical treatment, such as adenotomy, ventilations tubes insert, tympanoplasty and hearing implants implantation. **Conclusions:** Hearing loss is common in patients with TS and has a negative effect on quality of life. Conductive hearing loss can be caused by middle ear diseases. The cause of sensorineural hearing loss is unknown, but several hypotheses such as estrogen theory,cell cycle delay hypothesis or the SHOX-gene theory are discussed. Patients with TS should be screened for onset and progression of hearing loss.

Hearing screening in school-age children from Kyrgyzstan: Results of screening and follow-up

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Background: According to WHO data, hearing disorders are commonly encountered in school age children. Screening tests have an extremely important preventive role, constituting the primary tool of secondary prevention. Expenditure on early support for child development can contribute to reducing future outlay on health care and social services by eliminating the problem of disability, education deficits and social maladaptation in adult life. **Aim:** The purpose of this study was to evaluate the prevalence of hearing loss in screened children in Kyrgyzstan and referring pupils with positive results to the diagnostic tests. **Material and methods:** Prior to testing, the children's parents were informed of the testing procedures and signed a consent form for their children to participate in a hearing screening examination. There were 452 children – 289 (63.9%) 7–8 years old and 163 (36.1%) 11–13 years old. The children attended public primary schools in Bishkek in Kyrgyzstan. Pure-tone air-conduction hearing threshold were obtained at 0.5–8 kHz. Hearing loss was defined as a pure-tone average higher than 20 dB in one or both ears in at least one of the tested frequency. **Results:** Based on the result of the audiogram, screening showed that hearing impairment was found in 123 (27.2%) of the examined pupils. Information how many out of 123 children with positive results received follow-up testing and intervention services was not available, but we managed to collect follow-up data of 27 children with positive results. **Conclusions:** It reveals that hearing problems are common in this population. The study has important implications for clinical practice and health policy to introduce low-cost and routine hearing screening. There is need for systematic monitoring of hearing status among children and increasing awareness of parents and educators of the significance of hearing loss.

High-definition transcranial direct current stimulation does not decrease tinnitus severity: Results from a double-blind randomized controlled trial

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Objectives: Transcranial direct current stimulation (tDCS) has been proposed as a potential management strategy for subjective tinnitus, but supporting evidence remains limited. We aimed at investigating the effect of anodal high-definition (HD) tDCS of the left temporal area (LTA) and right dorsolateral prefrontal cortex (rDLPFC) on tinnitus severity. **Material and methods:** This double-blind randomized controlled trial included 77 patients with chronic subjective tinnitus as their primary complaint. Thirty-eight subjects received 6 consecutive sessions of dual-site sequential HD-tDCS with electrodes positioned over the LTA and rDLPFC. Both areas were stimulated for 15 minutes per session, with total stimulation time amounting to 30 minutes. Thirty-nine subjects received sham stimulation. The primary outcome measure was the change in tinnitus severity, as evaluated by the Tinnitus Functional Index (TFI), from baseline to a follow-up visit at 8 (±2) weeks after treatment completion. Secondary outcomes included changes in tinnitus loudness, both as measured subjectively via a Visual Analogue Scale (VAS loudness) as well as using a tinnitus matching procedure (matched loudness), scores on the Hospital Anxiety and Depression Scale (HADS), and scores on the Hyperacusis Questionnaire (HQ). **Results:** No differences in TFI change scores were identified between the active treatment and sham control groups (linear regression: p=0.86). TFI scores decreased significantly over time in both groups (p=0.0012), indicating the presence of a considerable placebo effect. TFI change scores were significantly influenced by sex (linear regression: p=0.037) and baseline symptoms of anxiety (linear regression: p=0.049). In general, TFI scores decreased more profoundly in men and in subjects with a higher degree of anxiety at baseline. None of the included secondary measures differed significantly between experimental arms, although there was a trend towards a decreasing matched loudness in the active HD-tDCS group (linear regression, corrected for multiple comparisons: p=0.11). **Conclusions:** Our results suggest that dual-site sequential HD-tDCS of the LTA and rDLPFC does not alleviate tinnitus severity. Furthermore, fluctuations in tinnitus severity may be importantly influenced by sex and concurrent psychological complaints. We report important considerations concerning patient recruitment and exclusion criteria to take into account when conducting future randomized controlled trials in a tinnitus population.

How bilateral vestibulopathy affects cognition in older adults corrected for hearing status: A prospective cross-sectional study

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Background: A growing body of literature suggests a significant impact of the vestibular system on cognitive function, and visuospatial processing in particular. A higher prevalence of vestibular loss has been observed in people with varying degrees of cognitive impairment while hippocampal atrophy, an important biomarker for Alzheimer's disease, has been associated with vestibular decline. However, the co-occurrence of sensorineural hearing loss in people with vestibular loss has often been overlooked and may have produced unwarranted conclusions. **Objectives:** The primary objective is to investigate cognitive function in older adults with bilateral vestibulopathy (BV) taking hearing status into account and compare these results with a healthy control group. The secondary objective is to explore multiple vestibular characteristics (including measurements of the peripheral vestibular end organ, clinical balance testing and questionnaires) and their potential influence on cognition within the BV population. **Material and methods:** This study included 34 people with a diagnosis of BV according to the Bárány Society criteria. Each control was individually matched based on age, gender and best aided hearing performance. All subjects underwent cognitive, vestibular and hearing assessments. The primary outcome measure was cognition, measured by the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals (RBANS-H). **Results:** Overall, people with BV obtained a significantly lower score on the RBANS-H total scale. This decline was most pronounced in the subdomains of immediate memory, visuospatial and attention. Language and delayed memory subdomains remained preserved. Within the BV population, only one vestibular parameter (the Performance-Oriented Mobility Assessment, in particular the balance subscale) was significantly associated with lower cognitive scores. Further vestibular parameters, including measurements of the peripheral vestibular end organ and questionnaires, demonstrated no association. **Conclusions:** The older adult BV population demonstrated worse cognitive function in general in comparison with a healthy control group, which was most pronounced in the subdomains of immediate memory, visuospatial and attention. On the other hand, language and delayed memory subdomains remained preserved. This cognitive loss was found to be independent of concurrent hearing loss. Only one clinical balance assessment was associated with the observed lower cognitive scores in the former population. Other vestibular parameters such as measurements of the peripheral vestibular end organ and questionnaires demonstrated to significant association. These results support and extend evidence on an association between vestibular loss and cognitive impairment, in particular Alzheimer's disease. Further research on the causal mechanisms underlying this association and the impact of vestibular rehabilitation on cognition is needed.

How well do current measures of listening assess everyday communication?

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Objectives: Social communication requires the ability to perceive and understand language in the context of others, and the capacity to interpret and respond to information in the dynamic, multimodal, reflexive and collaborative landscape of bi-directional interactions. The requirements of communicative interactions contrast with the common representation and clinical measurement of listening as an internal and individualised ability. From an extended functional communication framework, this study aimed to provide a descriptive analysis of the current assessments used to evaluate listening skills that are necessary for oral communication in adults with hearing loss, and appraise the content of these assessments in comparison to broader constructs of functional listening and communication. **Methods:** Systematic searches (2008–2019) were conducted in multiple databases to retrieve peer-reviewed articles that used one or more linguistic-based measure necessary to oral communication in adults with hearing loss. A data charting form was used to extract and analyse the data of interest from included studies. As a second stage, a deductive content analysis was used to further analyse the items contained in the self-reported measures identified. **Results:** 9121 abstracts were screened against inclusion criteria, and of these 2522 articles met the inclusion criteria. Data synthesis indicated that discourse-based measures that are the foundation of social communication were used in 2.7% of the articles included. The self-reported measures' item analysis included over 2400 questions, from 118 questionnaires available in English with at least one item related to hearing. The content item analysis of self-report assessments demonstrated that pragmatic and linguistic constructs central to interactional communication were represented in only 9.2% and 7.6% respectively of the pool of items. Overall, the results suggest that current measures used in clinical studies to assess listening abilities relevant to oral communication target only a narrow set of domains that are part of the listening and communication construct. **Conclusions:** While a number of measures are used to assess

listening and communication abilities, it is evident that their content contrasts with existing functional communication constructs which highlight the importance of communicative interactions. Many of the core constructs of functional listening and communication have limited representation in current audiological measurement. Without considering the broader linguistic, cognitive and interactive elements of communication, existing measures of listening abilities may have limited clinical application to everyday communication, as experienced by an adult with hearing loss.

Impact of a receiver module with canal microphone on listening effort and acceptance, and resulting benefits for users and hearing care professionals

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Objective: Design and functionality of hearing devices are geared towards the everyday life of wearers – but do features add real life value? The perception of listening effort and awareness may differ from the confines of the clinic to the real world. The most popular style of hearing aids sold in the US and Europe today are receiver-in-the-ear (RIE). This style has advantages in terms of cosmetic appearance, convenience and ease of fitting, and performance. Nearly all RIEs today have dual microphones which can be used to provide significant signal-to-noise (SNR) improvements in noise. However, this microphone location also comes with disadvantages in terms of localization and spatial hearing. A recently introduced receiver module incorporating a canal microphone preserves individual pinna cues to assist listening in quiet and moderately complex environments, while the dual microphones on the device provide SNR benefit in complex listening situations. People fit with this receiver module have demonstrated better localization and preferred sound quality compared to fittings with a standard receiver module. It is hypothesized that these benefits may be reflected as reduced listening effort and preferences in everyday life. The objective of this lecture is to examine and compare outcomes in listening effort and user acceptance for traditional receiver-in-the-ear devices (RIE) and RIEs with an additional microphone on the receiver module. **Material and methods:** A cross over investigational research study was conducted with 24 participants. To assess listening effort, participants were fit with the receiver module with the canal microphone and a standard receiver, and an interleaved Adaptive Categorical Listening Effort Scaling (ACALES) was developed and used. Gottingen sentence test was used for speech evaluation. Ecological momentary assessment by RealLife Data EXP was used for patients to record their experiences in real time. **Results:** Results showed reduced listening effort when the canal microphone was active compared to omnidirectionality with the standard receiver, and a trend of reduced listening effort for the canal microphone compared to a pinna compensation algorithm using the device dual microphone system. Participants also wore each of the configurations for at least 2 weeks in a field trial where they recorded their experiences and rated sound quality and satisfaction using an ecological momentary assessment app. This data showed that both fittings provided benefit and satisfaction in individuals daily lives. **Conclusions:** Conclusions from these investigations highlight how hearing devices with a microphone in the ear canal can have advantageous effects for listening effort, localization and acceptance. The recent investigations indicate that test participants perceive differences in sound quality in background noise among three conditions: traditional omnidirectionality, average-based pinna restoration processing, and an additional microphone in the ear canal. Experienced users of hearing devices also show differences in spontaneous acceptance and localization ability. Additionally, results reveal reduced listening effort using an interleaved Adaptive Categorical Listening Effort Scaling procedure when canal microphones were active. Placing a microphone directly in the ear canal comes closest to the natural sound pick-up at the eardrum for a RIC hearing device, preserves pinna cues for localization, and assists in spatial separation of sound sources that is beneficial for listening in quiet and moderately complex speech in noise environments.

Importance of hearing screening in cytomegalovirus infection

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Objective: Congenital cytomegalovirus (CMV) infection is the most common non-genetic cause of sensorineural hearing loss(SHNL) in children. Only about 10–15% of children with congenital CMV are symptomatic, and majority of children are not diagnosed at birth. About 7% to 15% of clinically asymptomatic patients may develop late complications including SNHL, which is the most common sequelae in clinically asymptomatic patients. In this study, hearing status was investigated in children with confirmed CMV infections and neonatal hearing screening histories were reviewed to describe hearing loss caused by CMV. **Material and methods:** Retrospective review of 58 children with confirmed CMV infection was performed. Perinatal history including JCIH risk factors and clinical symptoms and signs of CMV infection were reviewed and hearing status were evaluated using age-appropriate audiological test batteries. **Results:** A total of 58 children (M: F=32: 26) were diagnosed with CMV infection from serological test (21%), PCR from serum (7%) and/or PCR from urine (27%). Mean age at diagnosis was 3.25 months (range: 0.5–3 months). Hearing loss was confirmed in 11 patients (18ears), bilateral in 7 patients (63.6%), and unilateral in 7 patients (26.4%). Degree of hearing loss was presumed to be mild in 4, moderate-severe in 3, severe in 1 and profound in 5 patients. It is noteworthy that only 6/11 (number of children with hearing loss) children with hearing loss due to CMV were diagnosed during routine NHS, and more patients (7/11) were diagnosed only after hearing evaluation was repeated following clinical diagnosis of CMV infection. **Conclusions:** Hearing loss is a serious complication of CMV infection in children and our results highlight the importance of timely audiological evaluation in children with clinically symptomatic CMV infection even if they have passed the NHS.

Indications and possibilities of revision surgery post stapedotomy

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Introduction: Surgical treatment is a standard procedure in cases of otosclerosis and other conditions connected with stapes immobilized in the oval window niche. The most often applied treatment is stapedotomy, meaning the replacement of the immobilized stapes by a prosthesis. The properly conducted operation provides stabile hearing improvement. **Aim:** The paper aims to present failures after stapedotomy operations, audiometric indications for the future operation, and postoperative changes occurring within the middle and inner ear in comparison to the hearing and balance examinations' results. **Material:** The authors of the paper conducted a retrospective analysis of the reoperation cases after prior stapedectomies and stapedotomies performed in our clinic and in other clinics. The authors present causes of the air-bone gap occurring postoperatively, as well as other difficult conditions after repeated operation. The authors discuss indications for reoperations and possibilities of the middle ear reconstructions. **Results:** Treatment is assessed based on the long term followup of the patients, otoscopic examination and results of pure tone audiometry and analysis of intraoperative assessments. **Conclusions:** Correctly performed operation with properly chosen prosthesis allows obtaining hearing improvement with closure of the air-bone gap. Reoperation is always a great challenge for the surgeon, and it requires experience and skills to reconstruct the middle ear. Proper assessment of the patient's condition before next operation allows lower the surgical risk and helps to choose surgical tactics.

Influence of tinnitus annoyance on hearing related quality of life in cochlear implant recipients

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Background: Tinnitus is the perception of sound without an external auditory input, often associated with aging and hearing loss. For cochlear implant (CI) recipients, there is no consensus on the impact of tinnitus on hearing-related quality of life. We hypothesized that hearing-related quality of life (QoL) in CI recipients is related to tinnitus annoyance. **Objective:** The aim of this study was to assess the relationship between hearing-related QoL measured by the Speech Spatial and Qualities of Hearing questionnaire (SSQ12) and tinnitus annoyance or perceived change in tinnitus annoyance with cochlear implantation. **Method:** The study sample consisted of 2322 implanted adults across France, Germany, Ireland, Italy, the Netherlands, Sweden and the UK. Hearing-related QoL, measured using the SSQ12, tinnitus annoyance and change in tinnitus annoyance, assessed using single-item questions, were acquired one or more years post-implantation. The relationship between SSQ12 total score and tinnitus annoyance or change in tinnitus annoyance was analyzed using linear models adjusted for age and implant configuration (unilateral, bilateral). Tukey pairwise tests were used to compare tinnitus levels. **Results:** Tinnitus prevalence was 33.9% post-implantation. This prevalence varied significantly with age (Chi square test, p=0.034). Recipients with tinnitus had significantly lower SSQ12 scores than recipients without tinnitus (mean difference 0.71; SD=0.09) SSQ12 units, F-test, p<0.0001). SSQ12 scores decreased significantly with age, tinnitus annoyance (linear model, p<0.001) and perceived change in tinnitus annoyance (linear model, p<0.001). Recipients rating their tinnitus as not at all bothersome had significantly higher SSQ12 scores than recipients with higher tinnitus annoyance levels (quite a bit bothersome: mean difference 1.23; SD=0.26) SSQ12 units, Tukey test, p<0.05, moderately bothersome: mean difference 1.32 (SD=0.27) SSQ12 units, Tukey test, p<0.05, extremely bothersome: mean difference 2.36 (SD=0.34) SSQ12 units, Tukey test, p<0.05). Recipients reporting that their tinnitus was much more bothersome since implantation had significantly lower SSQ12 scores compared with those rating their tinnitus as much less bothersome (mean difference 1.62; SD=0.29) SSQ12 units, Tukey test, p<0.0001). **Conclusions:** Overall, CI recipients who experienced less bothersome tinnitus showed better self-reported hearing related QoL. The association of better hearing performance with a positive change in tinnitus with cochlear implantation should be explored further.

Insights from mining a large pool of hearing device data logs

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Objectives: Real-world data (RWD) and real-world evidence (RWE) are gaining increasing attention in medicine and medical devices, e.g. as part of post-market surveillance activities. A foundational real-world metric is the average daily time a user is wearing his hearing device, aka Time on Air (ToA). With modern hearing devices, such as CIs, data-logs are collected automatically in the background as part of normal device use. Harvesting them is an efficient way to generate a representative set of user benefit data by describing and qualifying typical profiles. At current such data generation mostly relies on resource and time intensive clinical investigations or surveys with Health Care Professionals (HCP). Moreover, literature (Holder 2020, Schvartz-Leyzac 2019, Busch 2017) shows that receiving good benefit from a cochlear implant (CI) system correlates with the user's average daily Time on Air (ToA). This work reports on an analysis of a large set of usage data of cochlear implant listeners. **Material:** The Cochlear Link databases served as a basis for this data mining exercise. Cochlear Link is an infrastructure that allows to replicate clinical CI fitting software (Custom Sound) databases in a secure cloud. In February 2020, an anonymized snapshot was harvested for this analysis, containing data from over 600 clinics, 40,000 CI users and up to 5

years of CI usage. **Methods:** Our paper discusses the methodology used for mining a large pool of data-logs with the aim to describe and qualify typical ToA profiles. The available data pool was sliced in different dimensions to show ToA effects based on user factors (i.e., user age, implant tenure) and device factors (i.e., implant and sound processor types). Qualitative comparisons of ToA profiles of different user groups were performed to gain an understanding of the overall data set. Provided the sound environment detection feature of modern hearing devices, further differentiation of ToA profiles into underlying sound profiles were available. **Results and conclusions:** From this work we conclude that ToA is an interesting parameter that should be subject to further research in relation to user benefit/performance. Good benefit from a hearing device tends to be associated with good usage, aka higher ToA. In contrary, poor usage (low ToA) might be a precursor to non-usage, underlining the value of ToA as a clinical quality metric. Given the retrospective nature of this study, the causality between ToA and user benefit/performance could not be determined. By sharing these insights, we intend to promote further research into this topic.

International Ototoxicity Management Group (IOMG): A global effort to improve ototoxicity management for at-risk populations

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Objectives: The International Ototoxicity Management Group (IOMG) is a global consortium of international stakeholders dedicated to address major healthcare gaps in the clinical management of ototoxicity (hearing loss, tinnitus or balance deficits) caused by environmental toxicants and/or medications. We define ototoxicity management as the identification of at-risk patients, and the diagnosis, routine monitoring, rehabilitation and therapeutic management of hearing and balance deficits in affected individuals. Currently, there are no widely-used standardized guidelines or practices for ototoxicity management worldwide, despite the well-known detrimental effects that ototoxicity may have on quality of life. There are no standard methods for the auditory surveillance of individuals exposed to hazardous chemicals at work, and few healthcare delivery models integrate ototoxicity management into the systems of care that utilize ototoxic therapies for essential and/or life-preserving treatment. Challenges to implementation of ototoxicity management programs can include limited clinical and staff resources, poor interdisciplinary clinical communications, lack of awareness of ototoxicity for providers and families, and concerns about alternative therapy regimens for difficult-to-treat conditions. The IOMG objectives are to facilitate ototoxicity management practices that are contextually relevant, responsive, and high-quality across global regions, healthcare structures, unique clinical populations and work environments. This presentation will introduce the IOMG, its objectives and work-to-date, and provide attendees with information on how to get involved with this group and access its resources to improve their own clinical practice. These resources will connect attendees with current consensus opinions on gaps in ototoxicity management and strategies to address them. **Material and methods:** IOMG members, including international stakeholders from hospitals, universities, task forces, health foundations, professional societies, government agencies and patients, meet on a regular basis to discuss ototoxicity management priorities across clinical populations and workplace environments. There are currently four focus areas targeting: (i) ototoxicity of cancer treatment (chemo/radiation therapy), (ii) aminoglycoside-induced ototoxicity in patients with bacterial infections, (iii) environmental and occupational ototoxicants, and (iv) international perspectives. Representatives from external clinical organizations, governmental agencies and patient groups are appointed to liaise with IOMG to ensure our guidance is contextually relevant and valuable. An expert consensus opinion approach and formal literature reviews have been utilized to develop deliverables in each of the IOMG-identified areas of need. **Results:** IOMG productivity has included development of expert consensus opinions on gaps in ototoxicity management, publications and conference presentations on clinical perspectives and resources related to the implementation and efficacy of ototoxicity management, as well as improved stakeholder engagement, including pathways for outreach, networking events and community engagement. The IOMG has also dedicated efforts and produced deliverables for the identification of research needed to progress clinical management in this area, and we are making the results of these efforts available for researchers, funders, external organizations and other stakeholders. **Conclusions:** Consensus on guidance and tools for implementation and health promotion is needed to achieve a global standard of ototoxicity management. A multicultural and interdisciplinary approach is needed to support its application in specific medical, environmental and occupational contexts worldwide. The IOMG is dedicated to enhancing the social participation and quality of life of millions of individuals worldwide by partnering with patients, healthcare providers and external organizations to address gaps in ototoxicity management thereby giving patients and workers greater control over their long-term auditory and vestibular health. This content is solely the responsibility of the authors and does not necessarily represent the official views of the Department of Veteran's Affairs, National Institutes of Health, the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention or other funding agencies. Mention of any company or product does not constitute endorsement by these agencies.

Intra-operative measurement of the stapedius reflex via neurophysiological detection of stapedius muscle activity: A feasibility clinical study

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Objective: Objective fitting of cochlear implants (CI) still represents an important challenge in the audiological field. Reliable and reproducible fitting procedures might significantly contribute to improve the clinical benefits introduced by the CI's, most of all in non-compliant patients. Furthermore, potential development of next generation smart CI processors would greatly depend on a reliable and objective fitting methodology. Finding methodologies providing reliable monitoring of the stapedius reflex (SR) and detection of the SR threshold (SRT) – given its acknowledged correlation with the most comfortable loudness levels (MCL) – is therefore a crucial aspect. The retrofacial approach is a surgical procedure allowing a direct intraoperative access to the stapedius muscle (SM) unlocking the possibility of neurophysiological monitoring of the SM and the measurement of its electromyographic signal. **Aim:** The aim of the current study is to test the feasibility of intraoperative recording of SM electromyographic (EMG) signals related to acoustically and electrically evoked SR in single sided deaf CI candidates. **Material and methods:** A multicentred clinical study was set up in Tübingen and Jena, to assess SR-related EMG responses in 7 single-sided CI-patients. During standard CI implantation surgery to reach the belly of the stapedius muscle (SM), an EMG electrode was placed on the muscle belly. Access to SM was performed via either a retrofacial approach, or from drilling of the pyramidal eminence (PE), according to individual anatomy and pre-operative planning. During a pre-surgical decisional phase, 3D reconstructions produced after manual segmentation of Dyna Computed Tomography (Dyna-CT) images of the CI patient's temporal bone were evaluated. 3D renderings were available for consultation along all the duration of the surgery. Elicitation of the reflex was done via both contralateral acoustic stimulation (via tympanometer) and ipsilateral electrical stimulation (via the CI). Several frequencies and intensities were used for acoustic stimulation, as well as several CI channels were stimulated at different intensities during electrical stimulation. CI stimulation was performed at 250 pulses per second, in order to allow stimulation artefacts to be almost completely differentiated from EMG spikes, which enabled artefact removal and not only basic filtering during post-processing of the data. The contraction of the SM (movement of the stapedius tendon) was assessed visually via the microscope to determine whether a SR was present, and at the same time EMG recordings were performed to obtain the neurophysiological response. EMG measurements were analysed in post-processing, but for most supra-threshold stimulations, EMG spikes were clearly seen on the raw unfiltered signal during the trials. **Results:** The muscle was accessed via retrofacial approach in 71% of the cases (5/7 patients) and via anterior approach in 43% of the cases (3/7 patients). On 1/7 cases both approaches were performed following intraoperative decision of the surgeon since the anatomy allowed it. SR – EMG signals were successfully recorded in 71% of the cases (5/7 patients). EMG-based thresholds were calculated based on the signal-to-noise ratio during the stimulation, data analysis showed a Pearson correlation of 0.95 between the thresholds detected via EMG and those detected visually by the surgeon – movement at the level of the stapedius tendon. The EMG signal showed a high sensitivity, being detected even before the visual confirmation in 33% of the assessed cases. **Conclusions:** Our results confirmed that it is possible to reliably record SR-related EMG signals intraoperatively. The methodology for accessing the SM and subsequent electrode placement was found safe and effective, following an imaging-based pre-operative evaluation.

Is there a need for Country/Race-Based Average RECDs?

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Objectives: Children have smaller ear canal volume and higher ear drum impedance than adults. Given the same sound source, smaller ear canal volume is associated with higher sound pressure level and higher impedance may change the amount of sound transmission into the middle ear. Obtaining individual real ear coupler differences (RECDs) is a common method used during hearing aid fitting to account for individual ear canal differences. If not possible, the average RECDs for the child's age are often used. As the two hearing aid prescriptions (DSL and NAL) with average age RECDs were developed in countries with predominantly Caucasian populations (i.e., Canada and Australia, respectively), it is unknown whether these values are applicable to children in other countries. The objectives of this study were to compare the ear canal volume and middle ear compliance of children ages 3–17 years living in Brazil and in the United States (US) to examine whether country/race-based average RECDs should be explored for fitting hearing aids to children living in different countries. **Material:** The tympanometry test results of routine hearing tests were analyzed. Welch Allyn otoscopes and EroScan Pros were used to perform otoscopy, tympanometry, distortion product otoacoustic emissions, and acoustic reflexes. EarScans were portable audiometers used to test children's pure tone audiometry. The EroScan Pros were calibrated within 4 months of testing by the manufacturer and the EarScans were calibrated to meet the requirements of American National Standards Institute during each week of testing. **Methods:** More than 1500 Brazilian students were recruited from schools in Bauru, Boraceia, Joao Pessoa, Macaiba and Rondonia and >500 US children participated in the study. Children's outer, middle, and inner functions were examined using otoscopy, 226 Hz tympanometry, and distortion production otoacoustic emissions at 1.5, 2, 3, 4, 5, and 6 kHz. If they did not have otoacoustic emissions with signal-to-noise ratios ≥6 dB present at four frequencies or more,

they were tested with play or standard pure tone audiometry at 0.5, 1, 2, and 4 kHz. Children older than 7 or 8 years were also tested at 0.25, 6, and 8 kHz. The ear canal volumes and middle ear compliance of children at the same age were grouped and analyzed. Ears with accumulated wax blocking 75% or more of the ear canals or with Type B or C tympanograms were excluded from the analysis. **Results:** Brazilian and US children had similar ear canal volumes from age 3–17 years. Brazilian children, however, had significantly higher compliance than US children at 3 (NBR=45 ears, NUS=35 ears, p=0.0012), 4 (NBR=92 ears, NUS=70 ears, p<0.0001), and 5 years (NBR=87 ears, NUS=107 ears, p=0.008). No significant systematic difference was observed at other ages and the compliance of Brazilian and US children converges after 8 years old. **Conclusions:** As RECDs generally have a large variability and Brazilian children ages 3–5 years had lower compliance than their US counterparts, it is important to obtain individual RECDs for this age group to ensure their hearing aids are not providing overamplification. The findings also suggest that age- and country-specific RECDs may be needed for Brazilian children ages 3–5 years. Future studies need to examine whether such RECDs are needed for Brazilian children ages 0–2 years.

It's a family thing: Authentic ways to effectively involve communication partners in appointments

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Hearing loss should not be considered an individual problem: it is always shared and shaped by the environment and social context (Tjørnhøj-Thomsen & Philipsen, 2019). Hearing loss has a well documented impact on both the individual, as well as their families and communication partners. The impact of hearing loss on the family is acknowledged by the World Health Organisation as a third party disability (2001). In spite of this, contemporary hearing care appointments do not routinely involve communication partners in an effective way. Third party disability is not typically measured or addressed in audiology consultations, even though tools and resources to this end are readily available. Family members and communication partners should be included in the diagnostic and rehabilitative pathways, not only because of third party disability, but also because research indicates that their inclusion plays an important role in the help-seeking behavior of the person with hearing loss (Meyer et al, 2014), and in the success that they have later in using hearing aid technology (Hickson et al, 2014). Research also suggests that audiologists are in a unique position to facilitate these person- and family centred practices that are valued by professionals and consumers alike. Family members are interested to participate in and share their perspectives and experiences regarding their loved ones' hearing care. In spite of this, audiologists typically do not invite them to speak, would revert the conversation back to the patient after a brief interaction, and then tend to leave the communication partner "shut out" of the conversation between the patient and audiologist (Ekberg, 2015).

The Ida Institute have developed ethnographic documentaries to help clinicians explore the impact and value of family member perspectives to the traditional one-to-one view on the patient-clinician relationship. Active reflection, supported by the ethnographic method, can be a powerful tool to facilitate change and increase awareness and sensitivity to the challenge of effective and authentic, family centred hearing care. Ida, in collaboration with hearing care professionals from around the world, have also developed a number of clinical tools and resources to enable the inclusion of communication partners in the hearing care journey. This workshop will provide hands-on experience for clinicians to work with families and communication partners before, during, and after their appointments using a combination of telecare and face-to-face resources. It will provide practical strategies and peer feedback to work with families in a collaborative way that supports the development of healthy and productive therapeutic relationships.

Levels of traffic noise exposure on public transport drivers in South Africa: Where are the audiologists?

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Background: Globally, millions of people are exposed to road traffic noise above the daily threshold of 55 decibels. Traffic noise is the biggest contributor and a serious threat to the health of those exposed to noise. Public transport drivers are the most affected by traffic noise as the nature of their work is dictates that they spend most of their time on the road transporting millions of commuters daily. Evidence suggests that most of the drivers are not aware of the impact of excessive exposure to their health and wellbeing. Furthermore, these drivers are not aware of the role of audiologists in the management of hearing difficulties. **Aim:** The aim of this study was to determine taxi drivers' awareness of the long effects of traffic noise and the role of audiologists in the management of auditory symptoms. **Methods:** A cross-sectional quantitative research design was conducted with 86 taxi drivers who were recruited through purposive sampling. A self-developed questionnaire consisting of open and close-ended questions was used to collect data. Data were analysed quantitatively. **Results:** 51% of the participants reported to not being sure of what an audiologist is, while 28% of the participants knew what an audiologist is; however they associated an audiologist with mine workers and individuals with profound hearing loss or deafness. Furthermore, 73% have not had their hearing tested. Of the 27% who have had their hearing tested, only 7% had their hearing tested in the last five years. 41% believe that they should have thier hearing tested while 35% are unsure and 24% believe they do not need to have their hearing tested. **Conclusions:** The role of an audiologist in the life of an everyday man like a taxi driver is still unclear. Audiologists possess knowledge of environmental noise and its effects; however, individuals like taxi drivers may not be aware of the role of audiologists in their lives. There is a need to raise awareness around environmental noise and its effects particularly on people whose livelihood exposes them to environmental noise. Despite audiologists' knowledge of noise pollution being an important environmental risk factor for human health and the high exposure of drivers to urban noise, there is still a dearth of studies on environmental noise and more so in taxi drivers. Therefore, the implications of this study include raising awareness on the role of audiologists in educating taxi drivers regarding the effects of environmental noise.

Listening effort for persons with profound hearing loss

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Background: Persons with profound to severe hearing loss risk losing information due to problems with auditory communication, especially in noisy situations. The person need to combine the auditory signal with visual input to be a part of a conversation. Nevertheless, the communication is effortful and in order to reduce the effort there is a need of beneficial hearing aids. **Objectives:** The study aimed to investigate the impact of a noise reduction system, Oticon Opn Sound Navigator, on listening effort for speech perception for person with severe to profound hearing loss. **Material:** Data from 19 experienced hearing aid users (aged between 23 and 70 years) with severe to profound hearing loss (i.e. PTA4 >70 dB HL) will be presented. The participants were tested at the Audiological Research Centre, Örebro, Sweden. **Method:** In the study the participants were booked for 2 visits at the Audiological Research centre. First visit were to establish baseline data for hearing and cognitive function. The participants were measured with hearing tests; pure tone audiometry and speech recognition test. Furthermore, they were evaluated with cognitive tests, e.g working memory tests. They were also fitted with a pair of Oticon Xceed hearing aids. They had an acclimatization period, with the hearing aids, for 14 days in their own daily environment. At the second visit, they were evaluated with speech recognition tests and listening effort while using the Oticon Xceed hearing aids. Listening effort were evaluated with both pupillometry and subjective rating. The listening effort were evaluated with the Oticon Xceed hearing aid in two settings, with the Opn Sound Navigator on respectively off. **Results:** The results shows that persons with profound hearing loss gain from an effective signal processing in order to reduce the strain of hearing speech in a noisy environment. More than half of the participants preferred the new hearing aid compared to their current hearing aid, and stated a better possibility to achieve spoken stimuli not just in the test setting but also in their daily environment. Compared to results in previous studies of listening effort, with the Opn Sound Navigator, the benefit is lower for persons with profound hearing loss than to persons with milder hearing loss probably due to the lack of visual input in the test setting. **Conclusions:** Since persons with profound hearing loss are more dependent on audio-visual stimuli than persons with milder hearing loss, there is a need of further studies to evaluate the total benefit of the signal processing system where audio-visual stimuli is used.

The presented study is a clinical test of the Oticon Xceed hearing aid and has been funded by the Oticon A/S.

Location dependency of facilitation in electrically evoked compound action potentials

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Objectives: Electrically evoked compound action potentials (ECAPs) objectify the auditory nerve's response after stimulation with a cochlear implant (CI). ECAPs usually show stability over years, but exhibit high interindividual and electrode-specific variability. Facilitation (temporal summation) can be detected in ECAP measurements after high-rate stimulation of the auditory nerve. The relationship between electrode-specific variability in ECAP measurements and evocable facilitation across the cochlea is yet unclear and will be investigated here. **Material and methods:** Electrode-specific facilitation was investigated in 20 CI patients (CIx12 or CIx32; Cochlear Ltd.) using ECAPs. Measurements were made at five obligatory electrodes distributed equidistantly across the electrode array (El 1, 6, 11, 16 & 22) and at three other optional electrodes (E2–E21). Optional electrodes were chosen by the lowest visual ECAP thresholds. Paired pulse stimulation was used with very short interpulse intervals of 13 μs (masked response extraction). For normalization, the measurements were adjusted to subject- and electrode-specific ECAP thresholds. For the optional electrodes, additional series of measurements were carried out with suprathreshold probe pulses up to the loudest acceptable presentation level (LAPL). Control series of measurements were performed at an obligatory electrode in the same manner. **Results:** Facilitation could be detected in all subjects. The maximum evoked facilitation occurs at all electrodes as well as all suprathreshold probe current levels at the same amplitude of masker current level and ECAP threshold. The detection rate of this effect is higher at the apical electrodes than at the basal ones. Electrode-specific inhomogeneities with reduced facilitation amplitude occurred in approximately 20% of the measurements. Low ECAP thresholds are associated with reduced facilitation amplitudes and an increased electrical dynamic range. In these cases, no facilitation amplitude is detectable with suprathreshold stimulation up to +50 current level. **Conclusions:** Temporal summation effects are involved in the modulation of auditory perception. Local inhomogeneities occur regularly and may reflect intracochlear hypoexcitability of spiral ganglion cells. Contrary to the assumption that electrodes with a low ECAP threshold are more sensitive to electrical stimulation, no facilitation can be evoked here.

Manual positioning of bone conductors in pediatric ABR: Intra- and intersubject variability

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Correct placement of bone conductors (BC) during auditory evoked potential recordings is not always easy in young pediatric patients. Especially during time-consuming auditory brainstem responses (ABR), a stable positioning of the BC-transducer might be problematic since most BC-springs

are designed for adults and doesn't properly fit on small head, inducing less pressure than 5.4 Newton. In practice, most clinicians keep the BC-transducer in place by manually holding the transducer with one or more fingers or using a head band. However, this might induce variability in skull pressure and possibly influence the auditory thresholds. Particularly, when pressing the BC-transducer manually, it is not clear how manner of grip affects the outcomes.

The present study investigated the accuracy and effect of holding the BC-transducer (B81) under different manual grips, e.g. with two fingers on top, sideward, and pressing with only one index finger. The pressure force (N) is investigated under 3 different grip conditions, with different time courses (up to 8 minutes), different forces (4 levels, ranging 2.2–7.5 Newton), between two different groups (experienced clinicians, who are familiar in assessing BC-ABR in pediatrics vs. group of non-experienced subjects) and for different stimulation frequencies (250 Hz, 500 Hz, 1k, 2 kHz, 4 kHz). Force pressure was calibrated using Investigator BK2276 and Artificial Mastoid BK4930 (Bruel & Kjaer).

Interestingly, results reveal no significant differences in skull force between conditions, although one grip (i.e. pushing the BC-transducer downwards with index and middle finger) show significantly more variability (less stable) compared to lateral grip of the transducer. We therefore suggest to use the latter, although all variations in pressure varied between 1.9–7.0 Newton. Fatigue (1–8 minutes continuous grip) seem to play a lesser role than expected. No significant differences were found between different frequencies and between experienced and non-experienced subjects, the latter suggesting that acquisition of ABRs can be performed without having experience in holding the BC in place, provided that investigational instructions are the same. Suggestions for future development in practical tools to keep BC-transducers stable in babies are addressed.

Mapping the standard of care and the resulting health outcomes in patients with chronic otitis media

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Objectives: Management of patients with chronic otitis media is multidimensional and requires an array of surgical and non-surgical interventions to treat the infection and the associated hearing loss. The current treatment pathway is poorly characterized and limited reporting of outcome data act as a barrier to delivering evidence-based, patient-centred care in this patient group especially when it comes to treating the related hearing loss. To overcome these barriers, we are currently mapping healthcare utilization, health-related quality of life, and hearing outcomes in patients with hearing loss related to chronic otitis media as part of a multicentre, retrospective chart review (ClinicalTrials.gov Identifier: NCT04864912). An improved understanding of healthcare utilization and corresponding health, hearing, and quality of life data will drive clinical practice towards more effective treatments and more efficient utilization of limited health care resources. **Material:** The medical charts of 200 patients with chronic otitis media and a conductive hearing loss of >30 dB will be reviewed to capture healthcare utilization in the form of healthcare contacts and medications. Pre- and post-operative audiograms will also be collected from the medical records, or during follow-up if unavailable. Current health-related quality of life will be collected through completion of the Health Utilities Index Mark III and disease-specific quality of life via the Chronic Otitis Media Outcome Test-15. Patients will also complete the Speech, spatial and *Qualities of Hearing Scale* 12 to capture current hearing ability. Finally, the Client Service Receipt Inventory will be used to collect supplementary information on healthcare utilization and the impact of hearing loss on daily life. **Methods:** A retrospective multicentre clinical investigation with a minor prospective element will be conducted at six clinics across Germany, France and Spain. Two-hundred patients with hearing loss related to chronic otitis media that underwent a tympanoplasty between 2010–2015 will be recruited and their healthcare utilization and audiometric data extracted from the medical records up until the date of recruitment. Prospectively, patients will complete questionnaires to capture their current quality of life, hearing status and employment and educational attainment. **Results:** Episodes of care for individual patients will be presented and stratified by intervention type. Post-operative free-field PTA4 hearing thresholds following middle ear surgery, plus additional interventions, will be compared to those measured pre-operatively for the unaided condition. Hearing and quality of life outcomes will be stratified by intervention type. Productivity losses due to hearing impairment will be calculated. **Conclusions:** This investigation is a first step towards comprehensively mapping standard of care and its effectiveness in terms of hearing outcomes and quality of life in patients with chronic otitis media. These data can be used to direct evidence-based care and support more effective and cost-effective methods of hearing rehabilitation.

Mild-to-moderate hearing loss caused by STRC gene mutations in Russia

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Objectives: Hearing loss is the most frequent sensory disorder and is genetically heterogeneous. The most frequent cause of non-syndromic recessive hearing loss is biallelic pathogenic mutations in the GJB2 gene. 68% of congenital bilateral sensorineural hearing loss in the Russia identified in infancy are caused by mutations in GJB2 gene. Among other major causes of genetic hearing loss in different countries the STRC gene was also recognized. The rate of STRC pathogenic mutations reaches up to 5–13% in group of patients with mild-to-moderate hearing loss. **Material and methods:** We revealed and clinically examined 21 children and 4 adults with mutations

in STRC gene, including 12 unrelated cases and 13 patients from 5 families. All children except of one had no mutations in GJB2 gene. One kid was the carrier of 35delG mutation. All children have been examined first time in the age before 6 and 8 years. **Results:** Our data emphasize that thresholds from 35 to 60 dB nHL at 0.5–4 kHz are common for mutations/deletions of STRC gene. The phenotype of hearing loss appears to be mild-to-moderate. Stability of hearing thresholds during the entire period of observation is an impressive characteristic. Three children failed hearing screening based on OAE registration in maternity hospital, that indicates the congenital nature of hearing loss. **Conclusions:** It is concluded that in children with early revealed hearing loss the special approach is necessary which also includes consultation of parents on tactics and prognosis of the disease. Our results highlight the importance of the STRC gene as a major cause of mild-to-moderate hearing loss.

Music-listening level preference in musicians and non-musicians, and relation to vestibular function

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Objectives: This study examines differences in sound level preferences between musicians and non-musicians, and whether vestibular function could account for these differences. The anatomical proximity of the auditory and vestibular organs in the inner-ear leads to a close relationship between the hearing and vestibular systems. The vestibular system contributes to the auditory system and is connected with musical rhythm perception. Therefore, musical experience may affect auditory and vestibular systems, due to the greater contribution of the vestibular function to the auditory system in musicians compared with non-musicians. **Material and methods:** In the first part of this study, 92 musicians (46F/45M/1 non-specified) and 96 non-musicians (74F/22M), all with self-reported normal hearing and aged 18–45 years, completed a series of online questionnaires, including the activities-specific balance confidence scale (ABCs) as a proxy measure of vestibular function. In the second part of this study, 69 participants (44F/25M) from the first part completed an online music listening test (onlineMLP) to assess music-listening level preferences. Results: The data analysis showed musicians had slightly higher music listening levels (mean±*SD*=1.98±7.16) and ABCs scores (94.4%) than non-musicians (mean±SD=1.52±7.07 dB; mean ABCs score=93.8%). However, there were no statistically significant differences between the groups for the OnlineMLP (p=.915) or ABCs scores (p=.779). **Conclusions:** This study contributes a new online test assessing music-listening level preference. Our findings suggest there is little impact of musicianship on the preferred music-listening levels. The online ABC scale showed ceiling effects, and may not be suitable for measuring differences in vestibular function as a proxy measure between young, healthy, normal hearing musicians and non-musicians. In a follow-up face-to-face study, we intend to use vestibular evoked myogenic potentials to objectively evaluate vestibular function. To assist validate our online measure, we also plan to conduct an in-person version of the music-listening preference test.

Normalization of Navigation Test in Visual Data Exclusion

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Objectives: A person is able to perceive where he is in a three-dimensional plane. This can be achieved by spatial navigation and spatial memory. Spatial Memory helps us plan a route to a desired location; retrieving and storing the required information in the brain in order to remember where an object or event is. The visual, proprioception and vestibular systems, which ensure balance, are responsible in spatial navigation in humans, while cognitive and memory skills also play role. A possible disfunction in a person's vestibular system has a great effect in his spatial orientation and navigation skills. The Water Maze Test is used for animals, to test their navigation skills. This test is considered the gold standard for animals. The Triangle Completion Test is used to assess the navigation skills of humans. However, there are no normalization values for the currently used test batteries for humans. Our aim in this study is to obtain the normalization and standardization values for the navigation test battery in different age groups. **Methods:** In our study, by eliminating the visual system, which contributes to balance; we have assed the navigation systems of 153 healthy individuals, with no vestibular or proprioceptive problems. Participants walked on a coordinate plane with their eyes closed. The coordinate plane, with x and y planes included, consisted of squares of 25×25 cm, the whole coordinate plane being 300×300 cm. Seven commands were read to the participants in six different sets. At the end of every command set, we told the participants to go back to where they had started while measuring their reaction and duration time. The said followings were: • Command 1: 1 step forward, 1 step forward, turn right, 1 step forward, 1 step forward, turn right, 1 step forward; • Command 2: 1 step forward, 1 step forward, turn left, 1 step forward, 1 step forward, turn left, 1 step forward; • Command 3: 1 step forward, 1 step forward, turn right, 1 step forward, 1 step forward, turn left, 1 step forward; • Command 4: 1 step forward, 1 step forward, turn left, 1 step forward, 1 step forward, turn right, 1 step forward; • Command 5: 1 step forward, 1 step forward, turn left, 1 step forward, 1 step forward, turn back, 1 step forward; • Command 6: 1 step forward, 1 step forward, turn right, 1 step forward, 1 step forward, turn back, 1 step forward. Normalization values were determined based on the determined age groups, step lengths and the duration time for the person to return to where they had started. The most reliable and consistent of the 6 command sets read to the participants were determined with the statistical analysis. **Results:** The minimum and maximum deviations on x plane was observed in individuals whose ages are in the range between 21–29 (27.6048±27.27094) and 40–49 (34.7258±34.25272), respectively. On the other hand, for y plane, the minimum and maximum deviations were observed in the groups of individuals whose ages are less than 20 (27.3636±23.94072) and between 21–29 (35.4048±35.93685). However, according to the results obtained from Kruskal-Wallis test conducted for each plane (x and y) demonstrated that, there is statistically no difference in terms of deviations between age groups. According to the results obtained in the x/y plane of Kruskal-Wallis test; it was observed that the 1st command set made the least difference between the groups and most reliable test set for to use. **Conclusions:** As a result

of the analysis, it is recommended that the 1st command set be used as a viable test battery. For future research, we believe that these command set can be used in various diseases ranging from vestibular disorders to dementia.

Normative Wideband Tympanometry measurements in Australian school children

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Purpose: Traditional tests of middle-ear function, including 226-Hz tympanometry, use a single frequency to evaluate the integrity of the middle-ear system. Wideband Tympanometry (WBT), a newly developed test, uses a wideband stimulus to obtain more diagnostically useful information to describe the function of the middle-ear. **Objectives:** This study aimed to develop a normative dataset for Wideband Tympanometry measurements for frequencies between 226 and 8 000 Hz and variations in pressure from –200 to +300 daPa in Australian school children, and to determine the presence and impact of any gender, ear, ethnicity or age effects with regard to clinical practice. **Methods:** Data were collected cross-sectionally from ears of 922 children aged 4 years 5 months to 16 years 6 months determined to have normal middle-ear function by otoscopy, 226-Hz tympanometry, ipsilateral acoustic reflexes and pure tone audiometry, and without significant history of middle-ear dysfunction. WBT was measured and recorded for every child. Wideband absorbance values were extracted for three test pressures, 0 daPa (WBA0), tympanometric peak pressure (WBATPP), and peak pressure (WBAPP) as measured by 226-Hz tympanometry and WBT, respectively. Data were averaged over 1/3-octave intervals for analysis. **Results:** A significant difference was found between WBA0 and WBATPP, and WBA0 and WBAPP values. No difference was found between WBATPP and WBApp. A minimal but significant frequency-gender interaction was found across three test pressures. Wideband absorbance showed significant age effects in 11–12 of the 16 1/3-octave intervals at all test pressures. Age effects were most commonly observed between the 4–6 year and 10+ year, and 7–9 and 10+ year groups. Few significant differences were observed between the 4–6 year and 7–9 year groups. **Conclusions:** This study developed large-scale, age-specific normative data for WBA0, WBATPP, WBAPP in Australian children between 4 and 16 years of age. It was concluded that ear- and gender-specific norms are not required for clinical implementation but that age-specific normative data may be appropriate. Further, this study demonstrated that age-related changes in outer- and middle-ear function are present even when negative middle ear pressure is compensated.

Novel CAEP recording method using single-electrode stimulation: Feasibility assessment and results

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Cortical auditory evoked potentials (CAEPs) can be elicited by an acoustic or electric stimulation (in the latter case generally named also EALR, electrical auditory late response). They are composed of the P1-N1-P2 complex, corresponding to multiple generators on the auditory cortex. The P1 is generated by thalamus and auditory cortex and the latency of P1 is known to change with the development age of the auditory system, especially evident in children from infancy (where latency is around 200 ms) until childhood (where latency decreases to less than 100 ms). Therefore the P1 response is also called "biomarker" of the auditory pathway, since studying its latency is possible to investigate and infer about the maturation status of the auditory pathway and possibly on performance in children with CI (Sharma et al, 2015). Until now, CAEP response was usually collected in CI users applying an acoustic stimulus (tone burst or speech token) delivered with a speaker in a sound boot room to the speech processor worn by the CI user, which then converts the acoustic stimulus in electrical stimulation to the CI (Kosaner et al. 2018, Tavora-Vieira et al. 2018). An alternative and more effective way is to directly stimulate the CI via software for the CAEP generation, synchronizing the stimulation interface with the recording device. Here we will present CAEP responses from Med-El CI children collected with a standard EP device stimulating individually single CI channel with an electric burst via the fitting software Maestro v8.0, showing in detail the protocol and demonstrating the feasibility and the advantages of such procedure in recording CAEP in children.

Optimal protocol considerations for mHealth supported community-based pre-school hearing screening

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Introduction: mHealth supported community-based programmes facilitated by Community Health Workers (CHWs) have proven to increase access to hearing screening in developing contexts Seeing that this is achieved by mHealth utilizing automated tests with pre-specified screening protocols for result interpretation, it is imperative that optimal protocols should be considered Furthermore, validated referrals are key to successful screening programmes in resource-constrained settings. **Objective:** This study investigated and compared three screening protocols in order to recommend protocols that can be used in mHealth service-delivery models in a low-resource setting. The 3 protocols are described in terms of referral rate, instances of exceeded Maximum Permissible Ambient Noise Levels (MPANLs) and true positive screening results. The association between screening results and protocol, age, gender and excessive background noise levels are evaluated. **Methods:** Hearing and vision screening of all children (4 to 7 years of age) were done by the CHWs at the ECD centre using mHealth technology. During the screening, three different protocols were used. During the first protocol, screening was done at 25 decibel (dB) hearing level (HL) for 1000, 2000, and 4000 Hertz (Hz) in each ear; children missing one or more tones in either ear would fail to pass the screening. The second protocol determined that screening was done at 25 dB HL for 1000, 2000, and 4000 Hz in each ear; children missing two or more tones in either ear would fail to pass the screening. In the third protocol used, screening was done at 30 dB HL at 1000 Hz in each ear and 25 dB HL at 2000 and 4000 Hz; refer at any two frequencies in either ear

constituting a fail result. All three protocols included an immediate rescreen at the predetermined hearing level at the frequencies at which the child failed the initial test. Those who failed the screening were seen for a first line follow-up at their ECD two weeks later. If the child failed the hearing test at the first-line follow-up, they were referred to a diagnostic centre for confirmation of hearing loss and intervention. **Material:** Four Community Health Workers (CHWs) provided hearing screening to pre-school children at Early Childhood Development Centres (ECDs) in underserved communities in Cape Town using smartphone-based hearing assessment technology (hearScreenTM application and calibrated headphones, by the hearX group, South Africa) linked to a cloud-based data management The first-line follow-up hearing test was done by an Audiologist using the hearTestTM application on the same smartphone. **Results:** A total of 10 390 children were tested of which 2147 were tested using the first protocol; 5782 using the second protocol; 2461 using the third. The referral rates for initial screenings were 22 94%, 13 59% and 15 16% for protocols 1, 2 and 3 respectively. After an immediate rescreen, the referral rates decreased to 8 60%, 4 32% and 5 89% for protocols 1, 2 and 3. Exceeded MPANLs at 1000 Hz were much higher in protocol 1 and 2 (MPANLs were exceeded in 49 70% and 50 16% cases in the left and right ear in protocol 1 and 29 97% and 29 90% in protocol 2). During protocol 3, MPANLs at 1000 Hz were exceeded in 5 73% and 5 32% cases in the left and right ear. Participants who had true positive results as determined by the first-line follow-up were 33 74%, 43 87% and 65 44% in protocols 1, 2 and 3. **Conclusions:** Screening at 25 dB HL at 1000, 2000 and 4000 Hz with a refer at any two frequencies in either ear constituting a fail result, with an immediate rescreen, reduce referral rate. A screen intensity level of 30 dB at 1000 Hz reduces MPANLs being exceeded and increases true positive rates significantly. This avoids overburdening health care resources in LMICs.

Outcomes of cochlear implantation in children with incomplete partition type III

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Objective: The aim of the study was to present the surgical technique used for cochlear implantation in children with congenital inner ear malformation: incomplete partition t. III, and to discuss the results obtained after surgical treatment. **Material and methods:** Five children, four males and one female with an incomplete partition type III malformation, were implanted with a CI. Two of them bilaterally. The implantation technique included both cochleostomy and round window approaches. **Results:** Massive gusher appeared in 4 patients after opening the cochlea. One patient did not have gusher possibly because of almost complete ossification of the cochlea. Computed tomography results showed that the electrode was correctly positioned in most of the ears. In one patient the electrode was inserted into the IAC.The operations proceeded without complications. We also did not observe late complications. All children use CI, although hearing results differ from those obtained in patients with a normal cochlear structure.

Partial or total replacement prosthesis after modified radical mastoidectomy

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The objective was to analyse outcome and advisability of ossiculoplasty after modified radical mastoidectomy using Kurz Titannium prosthesis. Analysis of ossiculoplasties with partial ossicle replacement prosthesis (PORP) and total replacement prosthesis (TORP) operated between 2012 and 2016 was performed. Mean preoperative and postoperative air-bone gaps (ABG) and the changes in mean hearing loss were analysed using a four frequency (500, 1000, 2000 and 4000 Hz) pure tone average. Success rate was defined as postoperative air-bone gap closed to within 20 dB. Radical mastoidectomy is performed in substantially damaged ear, and yet, it is worth to perform reconstruction of the ossicular chain to improve hearing.

Perceived self-acceptance measure predicts CI-outcome in adult CI users

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Objectives: A broad range of factors is known to be associated with speech perception with cochlear implants (CI), such as age at implantation, deprivation of the implanted ear, the moment of deafness being pre or post lingual. Little research has studied the influence of person related factors, such as personal characteristics and optimism, to be associated with CI outcome. It is known from other rehabilitation processes that person related factors can be highly correlated with therapy adherence and rehabilitation outcome. The aim of our research is to study if an association between person-related factors and CI-outcome is likely to exist in adult CI-users. Our hypothesis is that higher positive scores on questionnaire items related to personal factors results in better speech perception with CI. **Material:** We conducted a retrospective study with post lingual deafened adult CI-users (*N*=45). We used the perceived pre implantation response to the CPHI35 consisting of the subscales Maladaptive Behavior, Verbal Strategies, Nonverbal Strategies, Acceptance of Loss, Self-Acceptance, and Stress and Withdrawal. As a measure for speech perception, we used the consonant-vowel-consonant (CVC) phoneme scores at 65 dB SPL in quiet prior to implantation and at 4, 6 and 12 months after rehabilitation onset. **Methods:** We performed correlations between the CPHI35 and the speech perception scores before and after implantation. After we identified cofounders and verified the assumptions for linear regression, we built a multivariate model. **Results:** Before implantation we found no correlations between the subscales of the CPHI35 and speech perception scores. However, post implantation we found significant correlations between the subscales Maladaptive Behavior and Self-Acceptance at 4 months after rehabilitation onset. Self-Acceptance was also associated with speech perception at 6

and 12 months. In a linear regression model including age at implantation and daily CI usage, the contribution of Self-acceptance to the speech perception at 6 months remained significant. The model explained 40.5% of the variance in the data. **Conclusions:** CI candidates scoring low on the subscale Self-Acceptance of the CPHI35 before implantation are at risk for lower speech perception with CI. Our findings show that person related factors should be taken into though when considering CI candidates.

Person centered care in audiology

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Research question: 'How is person-centered care (PCC) understood in South African audiology curriculum and clinical practice? **Objective:** To determine and describe understanding of PCC in south African audiologists. **Material:** A semi-structured interview schedule was adapted and utilised for data collection in this study. **Methods:** An exploratory case study design was undertaken to answer the study's 'how' based research question. The study population was made up of maximum variation sampled audiologists registered with the South African health professions council that were currently practicing in academia (curriculum) and clinical settings. Audiologists were chosen as the study population as they are knowledgeable about and were experienced within the field of interest, audiology practice within a South African context. Audiologists were interviewed and documents were also reviewed to answer the study's objective. All collected data was thematically analysed. **Results:** Three main themes were determined in describing PCC understanding among South African audiologists, namely Personhood, Active Engagement and Manner versus Method. Some of the categories within the above mentioned themes included support, interaction, equality and holistic care. **Conclusions:** This study, a first of its kind in South Africa, shows there is a clear understanding of PCC among audiologists in curriculum and clinical practice. This is a good indication that there is a meaningful insight on PCC thus, research can focus on investigating implementation of PCC in hearing healthcare.

Personalized Approach in the Diagnostic and Treatment of Tinnitus

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Tinnitus is a disease that affects millions of people. However, there is still no standard for diagnosing and treating this disease. What necessitates a lot of new research in this area? **Material:** 40 patients with Tinnitus studied at Audiology department of the State Institution "The Republican Center for Research and Practice in Otolaryngology", from 2018 to 2019 year. **Aim:** To determine the most effective method of management patients with Tinnitus. **Method:** Mathematical statistics, Student *t*-test, Fisher test. All patients underwent DPOAE, TEOAE, tympanometry and acoustic reflexes, Auditory Brainstem Response, high-frequency audiometry, Word Recognition test. **Results:** The study involved 40 individuals an equal man (N=23) and women (N=17) in the middle age at 32.31±10 years (95% CI 1855 years). All patients (N=40) were divided into 2 groups: 1 group (control) – patients with tinnitus with standard diagnostic and treatment plus white noise masking, 2 group (experience) – patients with tinnitus who were managed with personalized approach. It was found that statistically significant difference was observed between the both groups diagnosed with DPOAE and TEOAE. All patients successfully passed the TEOAE-test from 2 groups. But all patients showed lower results at 1501, 2002, 6000, 8000 Hz frequencies by the distortion-product otoacoustic emissions. It was significantly revealed an elongation or the shortening of the peak of I wave (t≥0.95) with an increase in the amplitude and an increase in the latency. Speech intelligibility was 80±5% (t≥0.95) in both groups. Based on the characteristics of the peak of I wave, drug treatment was prescribed to stimulate or inhibit the functioning of the auditory nerve in the experience group for 2 weeks. Additionally, in the group of experience group, listening to delta waves at a frequency of 5 kHz was assigned for three months. Significant difference was achieved in the experiment group and was accompanied by the restoration of the amplitude of the peak of I wave to 61.3±5.8% to normal and completely passing DPOEA during 6 months. **Conclusions:** Personalized approach increases the effectiveness of treatment of tinnitus and the quality of life this kind of patients.

Place-pitch discrimination over the full electrode array

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Objective: To investigate variations in place-pitch discrimination along the electrode array and to validate an improved version of our earlier published full-array pitch discrimination test. **Material and methods:** We tested twenty-five adults implanted with a cochlear implant (CI) from Advanced Bionics, mainly HiRes90K MS. All subjects had at least 6 months experience with their CI. The subjects performed two different psychophysical experiments on place-pitch discrimination. In both experiments, subjects had to identify one stimulus (probe) as being the odd-one-out compared to two reference stimuli, according to a three-alternative forced choice (3AFC) task. The reference stimuli were stimulated at the physical contact of interest and probe stimuli were created using simultaneous dual electrode stimulation (DES), also known as current steering. In the first experiment, three channels were measured, pre-determined (using multi-slice computed tomography) at 120° (basal), 240° (middle) and 360° (apical) from the round window. On these three channels, pre-defined inter-channel distances (ICDs) ranging from 2 (physical electrode contact distances) to 0.1 (DES, α=0.1) were tested, with 12 trials each. Psychometric functions (PF) were fitted with MATLAB resulting in the Just Noticeable Difference (JNDα), defined as the threshold at 66% correct. In the second experiment, subjects completed a pitch-discrimination task on every channel of the electrode array. This test used four discrete

ICDs: 2, 1, 0.5 and 0.25. After five repetitions on the 'easiest' probe condition (ICD=2) the score was evaluated, if ≥3 out of 5 repetitions were correct the ICD was decreased for the next round. The final discrimination score (Dα) was defined as the lowest ICD where at least a score of 80% (≥4 out of 5) was met. Lastly, we compared the subjects' channel discrimination results with their speech perception scores, using free-field consonant-vowel-consonant phoneme recognition scores as measured during the subjects' regular clinical program. **Results:** Twenty-four subjects completed the PFs for all three tested regions, while one subject completed only middle and apical PFs. The average JNDα across all subjects was 0.65; there was no significant difference between JNDα per region. The JNDα and Dα scores varied widely between subjects. The easiest probe condition, ICD=2, was distinguished on almost all tested channels. Both tests took approximately equally long to complete (±45 minutes). However, in that time frame only 3 contacts could be tested with the PFs, while the whole array was examined with the full-array test. To compare the PF outcome (JNDα) with the full array test outcome (JNDα) measured on the same channel, JNDα scores were grouped by their corresponding Dα scores 0.25, 0.5, 1 and >1. All groups were significantly different from one-another. Spearman's rank correlation indicated a significant positive correlation between JNDα and Dα score measured on the same contact (rs=0.64, p<0.001). Moreover, linear correlations showed a significant relationship between JNDα and speech perception score in quiet (speech at 65 dB and 75 dB SPL) and in speech in noise (speech at 65 dB SPL, SNR +10 dB). **Conclusions:** The significant relationship between JNDα and speech perception score indicates that pitch discrimination ability could be a useful parameter in clinical fitting. Furthermore, we identified a significant correlation between the gold standard JNDα and novel Dα outcomes. The full-array test distinguishes between pitch discrimination performance, in approximately the same time it takes to measure three more accurate PFs (±45 minutes).

Polish Sentence Matrix Test: Speech perception and hearing aid benefit measurement

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Objectives: Speech recognition in listeners with hearing loss is mainly affected in noisy conditions and can only be partially explained by the elevated pure tone thresholds. Therefore, speech audiometry in noise should become a standard tool in hearing diagnostics and for the assessment of benefit from hearing devices. The goal of this study is to validate the Polish matrix sentence test (PMST) for reliable assessment of speech recognition in different types of masking conditions for hearing-impaired listeners without and with hearing device(s). **Material and methods:** 35 normal-hearing listeners (NH, young *N*=18 yNH; older *N*=17 oNH) were included as a reference group. 58 hearing-impaired (HI) listeners with mild to severe hearing loss participated in the experiment for unaided speech recognition measurements in quiet and in different types of background noise. Speech reception threshold (SRT, 50% correct responses) was measured adaptively with the PMST in quiet, test-specific stationary noise (TSN), modulated noises ICRA5-250 and IFFM, and in realistic noise of cafeteria ambience. A separate group of hearing-impaired listeners was measured without and with hearing device(s). The same acoustic conditions were examined as in the unaided measurements described above. All listeners were experienced hearing aid users. SRT measurements were done with own hearing device(s) as well as with a simulator of hearing aid (Master Hearing Aid) which allows to systematically investigate and compare different processing schemes or interactions between different fitting rules. Here, compensation of hearing loss with NAL-NL2 as well as combination of NAL-NL2 with an adaptive differential microphone (ADM) noise reduction scheme was considered and compared to the performance with listener's own hearing devices. **Results:** SRT in quiet was highly correlated with the PTA (R2=0.84) and showed high sensitivity (97%). Weaker correlation with PTA (R2=0.6) but high test sensitivity (95%) and specificity (94%) was observed in the TSN condition indicating that speech recognition cannot be well described by the pure tone threshold in this condition. SRTs in modulated noises and cafeteria noise were well correlated with the PTA but also with the stationary noise. No differences in SRT were found between ICRA-250 and IFFM. Significant SRT differences between HI groups (mild, moderate and severe) were found in all considered conditions reflecting the high discriminative power of the test. For aided measurements, only weak relationship is expected between SRT measurements in quiet and in noise. Moreover, weak relationship is expected between well controlled laboratory conditions (TSN and modulated noises) and realistic noise of cafeteria ambience. **Conclusions:** the PMST with its high sensitivity, specificity, and discriminative power is an accurate and reliable tool for auditory diagnostics as well as for research purposes. Moreover, the PMST can be used for assessing the benefit of hearing devices in acoustically challenging conditions.

Postural control and perceived handicap in elderly patients with and without vestibular impairment

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Objectives: Vertigo affects around 49% of adults aged 60–69 years. It might have various aetiologies related to ageing and lead to falls. It seems that approximately 1/3 of adults (above 65 years) experience falls each year. As a result, vertigo affects daily functioning. The study aimed to find the relationship between postural stability and vestibular handicap in elderly patients with and without vestibular disorders. **Material and methods:** Analysis was performed on 35 patients (male *n*=15, female *n*=20) aged >65 years who had been consulted in the Otoneruology Department at the Institute of Physiology and Pathology of Hearing. The patients filled Dizziness Handicap Inventory (DHI) questionnaire and performed a battery of otoneurologic tests e.g. caloric test, Sensory Organization

Test (SOT). The caloric test result >25% was defined as the vestibular loss and the SOT<70 points was defined as a somatosensory problem. **Results:** Fifty percent of the patients with vestibular loss presented decreased results in SOT. The 80% of patients without a vestibular loss performed the test correctly. The patients with vestibular loss did not differ in SOT results in comparison with those without a vestibular loss ($\chi^2(1)=3.304$, $p=0.069$). There was a negative moderate correlation between the caloric test result and SOT ($r=-0.421$, $n=35$, $p=0.012$). There was no significant difference in DHI total score between the patients with vestibular loss and those without a vestibular loss ($t(33)=-0.946$, $p=0.351$). The patients with abnormal SOT results presented significantly higher DHI total scores than those with normal SOT results ($t(33)=2.644$, $p=0.012$). **Conclusions:** The vestibular impairment causes a major barrier in daily life functioning and might be dangerous for ageing patients. The caloric test diagnoses vestibular loss and it is correlated with the SOT result. The vestibular loss indicates decreased scores in SOT, however the SOT itself is not able to distinguish patients with or without vestibular loss, but it shows the overall functionality of the patients. The perceived handicap is higher among patients with decreased SOT scores and might be related to fear of falls. The DHI is a self-reported measure of a patient's handicap and allows to understand the problem in a more complex way. The study shows the relationship between postural stability and vestibular handicap in elderly patients.

Practicing preventive audiology: Promoting healthy hearing across the lifespan

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There is mounting evidence that healthy living contributes to healthy hearing. Diet, as documented with the Healthy Eating Index (HEI), is a critical factor influencing hearing status over a lifetime. Other healthy lifestyle choices, such as regular vigorous exercise, not smoking, and consistent use of hearing protection during exposure to high intensity noise or music, also contribute importantly to preservation of good hearing. In addition, hearing impairment in adults is associated with a long list of common chronic diseases, for example, diabetes, cardiovascular disease and stroke, rheumatoid arthritis, kidney disease, sleep apnea, and dementia. Conduct a literature search of 'comorbidity' and 'hearing loss' and you will find that the topic is attracting considerable clinical attention and research focus.

Five key steps in practicing preventive audiology will be reviewed: 1) Obtaining a comprehensive history including medical conditions and life style factors related to hearing loss; 2) Assessment with a diagnostic test battery that includes procedures with proven sensitivity to subtle auditory dysfunction (e.g., otoacoustic emissions, speech perception in noise tests); 3) Adequate patient counseling about the connection between healthy hearing and life style/healthy living, including strategies for hearing protection; 4) Audiological management to enhance communication, and 5) Close and consistent communication and management coordination with primary care physicians. This presentation offers a clinically feasible approach to maintaining healthy hearing, preventing hearing loss, and promoting quality of life from youth to advanced age.

Prediction of Cochlear Implant Outcomes in the elderly

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Objectives: To evaluate outcomes of elderly patients with cochlear implant (CI) and factors that affect speech performance. **Method:** Seventy-two elderly patients (60~80 years of age) with post-lingual sensorineural hearing loss who received CI were divided into two groups according to speech performance scores: the poor performance group (monosyllabic word scores <70%, $n=40$), and the good performance group (monosyllabic word scores ≥70%, $n=32$). The distribution and contribution of the potential factors related to CI outcomes was compared. We also identified how outcomes in speech,,performance could be predicted according to the causes of hearing loss. **Results:** The duration of hearing deficit was significantly related with speech performance after CI (the poor performance group: 24.44±19.43, the good performance group: 13.86±15.12, p<0.015*). Significant differences were not found between the two groups for the other factors (age at implantation, pre-operative residual hearing level, vestibular function, presence of associated symptoms (tinnitus, dizziness), education, region of residence (urban/rural), presence of job, and comorbidities). In the case of hearing loss caused by sudden hearing loss, Meniere's disease, otitis media, and otosclerosis, they were similarly distributed between two groups. Traumatic and drug induced hearing losses are usually found in the good performance group. The hearing losses due to unknown origin, presbycusis, and meningitis were mainly distributed in the poor performance group. **Conclusions:** Better prognosis in the elderly with CI can be expected in patients with short duration of hearing loss. Age at implantation, residual hearing level, and other known individual factors did not significantly influence on speech outcomes.

Preferred music-listening level in musicians and non-musicians

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Objectives: To establish whether preferred music-listening level differed between musicians and non-musicians, and whether preferred music-listening level was related to music genre preference and lifetime noise exposure. **Method:** Participants listened to 7 music samples from different genres and adjusted the listening level (dB(A)) until the music was loud and enjoyable. This was repeated three times and an average was taken. Lifetime noise exposure was estimated using the Noise Exposure Structured Interview (NESI). **Material:** Seventeen musicians (mean age=29.06 years; female $n=9$) and seventeen non-musicians (mean age=28.94 years; female $n=9$) with normal hearing. **Results:** Preferred music-listening level of musicians (mean=79.98 dB(A)) were significantly higher than non-musicians (mean=70.76 dB(A)) (Mann Whitney $U=241.5$, p<.001). The preferred music-listening level differed with genre preference ($Z=13$, p<.001), with the favourite genre being played the loudest. There was also a positive correlation between lifetime noise exposure and preferred music-listening

level (r=.583, p=.002). **Conclusions:** The findings support that musicians may be more susceptible to noise induced hearing loss than non-musicians. As such, the use of hearing protection is vital for hearing health and career longevity.

Preliminary results of a new stapedius-reflex-fitting-method for cochlear implant users

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Objectives: A novel setting for assessing the electrically evoked stapedius reflex threshold (ESRT) not requiring pre-ear-pressurization and not limited to a single probe frequency has been developed. Such a setting is currently being tested in a study enrolling adult and pediatric patients in subsequent age-blocks, running in Vienna (Austria) and Tübingen (Germany). **Material:** Patients implanted for at least 6 months with a Med-El cochlear implant (CI) are recruited in Vienna, Austria, and in Tubingen, Germany. After a successful tympanometry assessment and screening, ESRTs are measured with a commercially available tympanometry device for each active CI channel. Likewise, the ESRT measurement is also performed with the new setting without pre-ear-pressurization. **Methods:** Demographic data (age, gender, and hearing loss etiology and duration) were descriptively assessed. The median MCL values for each Med-El CI electrode obtained with a standard device and with the new setting were compared and assessed against the MCLs set during a behavioural fitting session. **Results:** At the time this abstract has been compiled we have enrolled 14 (8 in Vienna, and 6 in Tubingen) patients (6 male, 8 female). The average results show that the ESRT results obtained with a standard device and with our setting are very similar, but the ear probe stability and sensitivity might be greater using the experimental setting. The ESRT results of both settings are comparable with those of the behavioral fitting outcomes used to set the previous CI maps in terms of correlation. **Conclusions:** Our preliminary results show that measuring ESRT without requiring pre-ear-pressurization may become an interesting alternative for CI fitting.

Prevalence and severity of tinnitus in a representative rample of 70-year olds

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Objectives: Several studies have shown that the incidence and prevalence of tinnitus increases with age, but less is known about the severity. This study aimed at investigating the prevalence and severity of tinnitus in an age-homogenous population-based sample of 70-year olds. **Methods:** Data was collected within a large-scale geriatric population-based study in Gothenburg, Sweden, the H70 Study. A birth cohort consisting of 70 year old persons born in 1944 answered a questionnaire about tinnitus and performed pure tone audiometry. Valid results were available for 1128 (55% women, 45% men). **Results:** The overall prevalence of tinnitus was 30.4%. More men than women reported tinnitus (p>0.001). Tinnitus was perceived bilaterally by 47%, unilaterally by 28% and centrally in the head by 25%. Of those with tinnitus, 46% were mildly bothered, 13% were moderately bothered and 7% were severely bothered. Rates of severity were similar among men and women. Hearing loss was significantly associated with both prevalence and severity of tinnitus. **Conclusions:** Tinnitus affects nearly a third of the population at age 70. The prevalence of moderate to severe tinnitus, probably requiring intervention, is around 6% in this age group. Hearing loss is an important risk factor. The prevalence of moderate to severe tinnitus, probably requiring intervention, is around 6% in this age group. Hearing loss is an important risk factor.

Protocol: A realist review on hearing conservation programs in South African large-scale mines

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Background: The goal of hearing conservation programs (HCPs) is to prevent hearing loss, to preserve the existing hearing, and to provide workers with the knowledge and equipment they need to preserve their hearing. The South African mining industry has failed to achieve satisfactory results to reduce noise-induced hearing loss. Therefore, strategic and contextually relevant changes are required to reduce or eliminate occupational induced-hearing loss amongst mineworkers in South Africa. **Objective:** This study aims to develop an evidence-based theory on how HPCs work, for whom, and under what circumstances to reduce occupational-induced hearing loss amongst South African mineworkers. **Method:** A realist review will be conducted between October 2021 and February 2022 to examine how contextual factors trigger specific processes or behaviours (or "mechanisms") to reduce or eliminate occupational noise-induced hearing loss. This synthesis will follow five steps of Pawson's 2004 and 2005 guidance on conducting realist reviews: (1) developing the initial programme theory about hearing conservation programmes, based on a review of the scientific and grey literature, and multisector stakeholder workshops/interviews, (2) searching for evidence, (3) screening, selection, and appraisal of selected articles, (4) Data extraction and synthesis, and (5) refining the initial programme theory. In selected studies, patterns in context-mechanism-outcome (CMO) configurations will be uncovered across and between studies. This will help to support, refute or modify the initial programme theory, and ultimately produce a refined programme theory on why and how HCPs work and in what context. **Results:** The results of this study will be reported using the RAMESES guidance and reporting standards for realist synthesis. **Implications:** The complexity of HPCs poses challenges to their implementation to reduce occupationally acquired hearing loss to South African

mineworkers. The findings from this realist review will provide recommendations both to policymakers and mineworkers on how to reduce occupationally induced hearing loss.

Psychoacoustic frequency and spectral ripple discrimination in normal hearing subjects vs. cochlear implant recipients

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Behavioral studies show that frequency difference limens and spectral ripples discrimination might correlate with speech understanding. To what extent these stimuli can be applied in objective electrophysiological assessment in CI is not yet clear. For clinical application of using discriminative tasks in the latter (e.g. using auditory cortical evoked responses), research is needed to define reference data in normal hearing subjects, but also in CI recipients, who might have worse discriminative abilities. Ten normal hearing adults (control group) and ten adult MedEl CI recipients (experimental group) participated in this study. A single-interval paradigm was used to obtain individual psychometric curves of psychoacoustical frequency and spectral ripple discrimination thresholds. Besides these behavioral psychoacoustical thresholds. Stimuli consists of a reference frequency of 1000 Hz (1240 ms duration) tone with varying acoustic changes 0.2 to 10% FDL (Frequency Difference Limen: fbase+Δf), 620 ms after onset. For spectral ripples discrimination phase inversions were used with varying densities: 0.25 to 11.31 ripples per octave (RPO). Absolute auditory psychoacoustical and electrophysiological discrimination thresholds were analyzed and compared. Behavioral responses show discriminative thresholds for frequencies and ripples of 2.1% FDL and 1.2 RPO, respectively. As expected CI recipients show, compared to normal hearing subjects, worse discriminative capacities in frequency and spectral ripple discrimination i.e. psychoacoustical FDL's of 0.4% and a ripple discrimination of 13.8 RPO, respectively. Additionally, first preliminary electrophysiological application based on the present results of frequency and ripple discrimination tests are addressed.

Quality of life and psychological health in adults with acquired single-sided deafness

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Background: Single-sided deafness is a condition with profound hearing loss in one ear and normal hearing thresholds in contralateral one. It was considered for a long time that patients with single-sided deafness did not need any rehabilitation for bilateral hearing restoration. However, single-sided deaf patients have speech intelligibility difficulties in noise, inability of sound localization, suffer from tinnitus in affected ear, and are dissatisfied with the health-related quality of life as well. The research aims to assess the impact of acquired single-sided deafness to psychological health and quality of life in this group of patients. **Methods:** According to the aim of this study, two main groups were formed: a group of patients with single-sided deafness (n=25) and a control group of patients with normal hearing (n=25). Different questionnaires were used to assess psychological health and the quality of life (PHQ-9, GAD-7, PSQ, HHIA). **Results:** In accordance with the results of the study, an increased level of stress and anxiety was found in the main group of patients; the patients suffer from the various levels of depression and are not satisfied with the quality of life. **Conclusions:** Patients with acquired single-sided deafness suffer from an increased level of stress, anxiety and depression. Though patients with normal hearing suffer from depression as well, but less severe than patients with single-sided hearing loss and it may be related to age of patients and socio-economic factors. Patients with acquired single-sided deafness are dissatisfied with the quality of life in general, but mostly they have emotional distress.

Quantifying traffic noise pollution levels at taxi ranks in Johannesburg, South Africa

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Background: Despite the alarming increase in environmental noise pollution particularly road traffic noise in developing countries, there seem to be no awareness regarding the long-term impacts of noise, particularly, traffic noise on the health outcomes of individuals exposed to excessive noise. Additionally, there is a dearth of studies on noise and its effects utilizing the pollution modelling technique known as Pollution Standard Index (PSI) to analyse the impact of noise pollution on exposed individuals. The aim of this study was to investigate the noise levels commuters are exposed to and to apply PSI to determine level of exposure. **Methods:** We conducted a cross-sectional study at two taxi ranks, over 28 days. 84 noise measurements were collected using a sound level meter and a dosimeter at different times of the day and months, peak vs off-peak hours, busy days vs quite days respectively. Data were collected between April July 2019. We used the Pollution Standard Index to analyse data. **Results:** Noise levels were above the permissible commercial noise levels as they fell within the extremely dangerous noise sensitivity zone as determined by the PSI. Furthermore, the noise levels fell below the WHO maximum permissible levels of 90 dB. There was no statistical difference between the means of the open and closed rank. Dosimeter noise levels recordings fell within the satisfactory zone as measurements were below 300 pollution standard index, which is considered unhealthy. **Conclusions:** There is a need to raise awareness on the dangers and effects of noise pollution in developing countries, as these are the countries whose population is exposed to road traffic noise.

Real-time fMRI neurofeedback – a promising tool for treating tinnitus

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Chronic tinnitus is often associated with cognitive and emotional problems, such as excessive stress, sleeping disorders and

relaxation, anxiety disorders. We assumed that application of real time fMRI neurofeedback helps to reduce stress and negative feelings caused by tinnitus. Haller et al. made the first attempts to treat tinnitus with rt-fMRI-neurofeedback in 2010. Based on the results of studies showing that disruption of the auditory cortex with TMS promotes noise reduction (Kleinjung et al. 2005) Haller et al. conducted an experiment on which people suffering from tinnitus have undergone therapy aimed at reducing the activity of the auditory cortex. Surveys (TFIs) carried out 2 weeks after training showed improvement in 2 out of 6 subjects. More recent studies on the effectiveness of auditory cortex deactivation training in tinnitus therapy conducted in two experimental groups including continuous and intermittent neurofeedback showed greater effectiveness (at trend level) of continuous training measured using the TFI scale immediately after training and 6 weeks later (Emmert et al. 2017). The above results indicate the limited effectiveness of tinnitus therapy by reducing the activity of the auditory cortex with rt-fMRI-neurofeedback therapy. This is probably due to both the undetermined etiology of this disease and the early developmental stage of the therapy used. Recent reviews indicate the efficacy of rt-fMRI-neurofeedback in changing brain activity in targeted areas in approximately 60% of studies (Alkoby et al. 2018; Thibault et al. 2018) while behavioral changes are observed in about 40% of studies (Thibault et al. 2018), and clinical improvement of patients in 20–30% (Thibault et al. 2018). The relatively high effectiveness of modulation of brain activity using rt-fMRI-neurofeedback gives the possibility of a causal study of neuronal mechanisms in both a healthy brain and pathological conditions, and the study of the impact of the activity of various structures on improving the functioning of patients (e.g. amygdala in tinnitus [Davies'a et al. 2017]). Mechanisms of rt-fMRI-neurofeedback are particularly interesting from both a cognitive and clinical point of view. Understanding these mechanisms would make it possible to consciously modulate the activity of brain structures and their impact on the causes and symptoms of studied disorders. To this aim, by using the new possibilities resulting from the continuous development of new rt-fMRI-neurofeedback methods (training individualization, process training sessions, the use of machine learning methods) and the availability of open software (openNFT, opendecnef), we have undertaken research aimed at understanding the mechanisms of neurofeedback and the possibilities transfer of brain autoregulation skills between modalities of stimuli and feedback signals used. This work is proof of concept study.

Reframing hearing through cultural, social, and psychological lenses

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Background: Social relationships are central to mental health and well-being. Communication with others provides people with a sense of belonging, shared understandings, and shape religion, culture and society. For many, hearing is central to this. But hearing declines with age, and our social and environmental experiences can be affected by this which, in turn, can have negative effects on our well-being and mental and physical health. While general trends exist at a population level, the extent to which this occurs in an individual is not simply proportional to the amount of hearing acuity which has been lost. In fact, this is much more complex and relates more to our social, psychological, cultural and political environments and the ways in which these can shape disability. **Objectives:** To reframe adult-onset hearing loss through multiple lenses, which enables a broader understanding of the factors influencing hearing-related disability, and highlights multiple ways in which to address such complex health and social problems. **Methods:** Using the approach presented by Bacci (2016), questioning how "problems" are constituted in health policy, we critically interrogate how the issue of adult-onset hearing loss is problematized and the resultant effects that this has on the solutions proposed to address this. We then use a broader framework to better understand the problem of adult onset hearing loss. The lenses included a social/cultural lens, psychological lens and economic/political lens that enabled a better understanding of the disablement and disadvantage faced by older adults with hearing loss. **Results:** By exploring hearing loss through multiple lenses, rather than using the traditional limited approach of framing this through a health/disability lens, we put forward an alternate position, representing the problem more broadly to demonstrate the diverse ways in which hearing health can be achieved without a single focus on the individual using a deficit approach. For example, the social/cultural model rejects an individualising and deficit model of disability, emphasising instead the importance of collective action and identity, alongside individual rights and access. The social model views disability as a product of the mismatch between impaired bodies and the social, economic, political, informational and architectural environments. Solutions, therefore, include rethinking urban design and architectural solutions that improve the acoustic environment to reduce reverberation and background noise, and mandated captioning for all people to reduce the disadvantage for those who are hard-of-hearing. The psychologically-focused Common Sense Model proposes that individuals interpret and respond to two parallel systems of illness representations, the cognitive system for regulating the objective health threat (hearing changes), and the emotional system for regulating negative emotions, such as anxiety and depression. The psychological, social and cultural lenses shift attention from the "problem" of biological differences in hearing towards the ways in which these differences come to matter socially, culturally and psychologically. **Conclusions:** Reframing of age-related hearing loss away from an individual and deficit model enables a more holistic approach to managing the disabling effects of hearing loss. In particular, it provides a framework for professionals and families to better support those who are negatively affected by hearing loss. Importantly, it highlights the need for cross-cutting solutions to address age-related hearing loss that extend beyond health policy and healthcare.

Rehabilitation of children with congenital unilateral conductive hearing loss

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Objectives: Potentially, binaural hearing abilities in children with non-operable congenital unilateral conductive hearing

(UCHL) loss can be achieved with different amplification options. Amplification options comprise (semi)implantable devices, directly stimulating the inner ear at the impaired side. These devices improve audibility. However, whether the new bilateral input does result in accurate processing of binaural cues remains unclear. Limited benefit and even non-use after fitting has been reported. The implanted ear has to compete with the well-developed normal hearing ear. The child has to learn to use the new digital processed and delayed input and fuse it with that of the normal ear. From a technological point of view, the available amplification options are remarkable but also have limitations in gain and output. This results in an asymmetry in hearing even after intervention, which might disrupt binaural processing. Stimulation of the contralateral cochlea by means of transcranial bone-stimulation might affect binaural processing as well. Important and unresolved remaining question regarding treatment of UCHL are: i) Does treatment provide binaural hearing? ii) Does early implantation increase the chance in restoration of binaural processing?In children with UCHL the impaired ear is not fully deprived and stimulated through children's own voice and loud sounds. Cross-modal plasticity and plasticity at the level of the brainstem likely depend on different neuronal mechanisms. Reorganization of the auditory system in developmental monaural hearing loss is not fully understood. **Material and methods:** Participants underwent localization testing in unilateral and bilateral hearing conditions (unaided/aided). Broadband noise bursts (BB; 0.5–20 kHz), high-pass noise bursts (HP; 3–20 kHz), and low-pass noise bursts (LP; 0.5–1.5 kHz) were randomly presented at three different sound levels (45, 55, and 65 dB, A-weighted (dBA)). All stimuli had 150-ms duration and were randomly presented. **Results:** We demonstrate that sound localization is improved, especially for sound originating from the hearing-impaired side. The data indicate inaccurate processing of binaural cues. We demonstrate that early implantation with a bone-conduction implant or a middle ear implant does not result in better sound localization abilities compared to children implanted later in life. A complete overview of all the available invasive bone-conduction systems will be presented (Baha, Bonebridge, Osia). **Conclusions:** Considering the reported limitations parents can chose to wait until their child has reached an age at which he/she can make the decision concerning invasive treatment him/herself. Still, this is a difficult call to make since unilateral hearing comes with clear limitations in daily life.

Rehabilitation Professional's Competence in Differentially Diagnosing Deafblindness from Autism Spectrum Disorders: A Cross-sectional Survey

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Background: Early diagnosis and management of children who are deafblind is important to alleviate the effects of deafblindness on the development of the child who is deafblind and their families. However children who are deafblind are often misdiagnosed or diagnosed late. The misdiagnosis or late diagnosis has been attributed to many factors, one of which is the competence and confidence of healthcare professionals in differentially diagnosing deafblindness from other conditions, in most cases Autism Spectrum Disorder (ASD). The study therefore aimed to establish the competence and confidence of rehabilitation healthcare professionals in differentially diagnosing deafblindness from ASD in the South African context. **Methods:** A cross-sectional survey design was employed for the study. An online questionnaire was distributed to rehabilitation healthcare professionals (*N*=78) via Survey Monkey. Data were analysed using descriptive and inferential statistics. Ethical clearance and permission were sorted and obtained from relevant stakeholders prior to the commencement of the study. **Results:** 54% of the rehabilitation healthcare professionals in this study were competent in diagnosing ASD, while only 35% could diagnose deafblindness. In some instances, symptoms were classified as associated with both ASD and deafblindness, when in actual fact they were those of deafblindness. Speech language therapists had amongst all the rehabilitation healthcare professionals in this study, more knowledge of deafblindness. Furthermore, healthcare professionals who had between one and nine years of working experience had more knowledge of deafblindness. **Conclusions:** Deafblindness is underdiagnosed or misdiagnosed as ASD. This is due to the lack of competence and confidence in diagnosing it amongst rehabilitation healthcare professionals. The findings therefore highlight the need for training of rehabilitation healthcare professionals. Training on deafblindness could be included as part of the curriculum in the various undergraduate programs. Deafblindness could also form part of the Continuous Professional Development (CPD) training programs at various healthcare facilities. A team approach to the training would be ideal as it would facilitate peer learning and support. More research in the area of deafblindness is required as it will inform evidence based assessment, management and support strategies for children who are deafblind and their families.

Relation between speech perception in noise and P300 in young cochlear implant recipients

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Aim: Evaluating speech perception and discrimination ability of implanted young adults using electrophysiological and behavirol measurements. **Material and methods:** Cortical auditory evoked potentials (P300) and Matrix tests were used to investigate the ability to perceive and discriminate auditory stimuli in 20 successfuly implanted subjects aged from 18–30 years (CI). Additional selection criteria for the study included: (i) being a higher education student or a University graduate; and (ii) having verbal communication ability and no additional physiological/psychological problems. P300 responses were measured at 70 dBnHL for quiet and noisy situations with speech stimuli. The latencies of the N1, P2, and P3 waves were analyzed. For the Matrix test, speech perception scores of participants in noisy situation were determined. Participants presented pre and postlingual deafness with good speech recognition scores. **Results:** The difference between the N1, P2 and P3 latencies of the participants in quiet and noisy conditions was found to be statistically significant (p=0.000; 0.000; 0.043, respectively). Also, tt was observed that the P3 response from 10 subjects, recorded in quiet, disappeared in 5 cases when noise was added. The relationship between the P2 and P3 in noisy conditions and the TURMatrix tests was not found significant (p=0.775; 0.225, respectively). **Conclusions:** Participants have shown difficulty for understanding speech

in noise. This observation could be one of the main problems affecting the academic education process of young implanted people during their university education.

Relationship between electrically evoked stapedius reflex threshold (ESRT) and stimulus burst duration in a group of children using cochlear implants

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Objectives: Objective measures mostly used to fit cochlear implants are the are the electrically evoked action potentials in the first place, followed by the electrically evoked stapedial reflex thresholds (ESRT). Several studies have shown that the general correlation between ESRT and subjectively measured comfort levels (MCL) is high (Hughes, 2012; Alvarez et al, 2007; Gordon, Papsin and Harrison, 2004; Lorens et al., 2004). ESRT variation due to stimulus duration needs to be investigate specially in the pediatric population regarding deviation according to stimulus length as well loudness. **Material and methods:** 26 children at the age less than 5 years, Med-El CI users, with all 12 active electrodes, with no cochlear malformation. Stimulation parameters as follow: burst duration: 100, 200, 300, 500 ms, stimulating electrodes: 2, 6, 9, 11. **Results:** For 13 children we managed to complete the procedure and to record ESR threshold for all mentioned durations, for seven children we receive no ESR response, for the rest – we stopped the measurement. **Conclusions:** ESRT threshold values depend on such parameter as burst duration. Further measurements need to be done to find correlation between MCLs and objective threshold for different burst durations.

Relationship between metabolomics profile of perilymph in cochlear-implanted patients and duration of hearing loss

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Perilymph metabolomic analysis is an emerging innovative strategy to improve our knowledge of physiopathology in sensorineural hearing loss. This study aims to develop a metabolomic profile of human perilymph with which to evaluate the relationship between metabolome and the duration of hearing loss. Inclusion criteria were eligibility for cochlear implantation and easy access to the round window during surgery; patients with residual acoustic hearing in the ear to be implanted were excluded. Human perilymph was sampled from 19 subjects during cochlear implantation surgery. The perilymph analysis was performed by Liquid Chromatography-High-Resolution Mass and data were analyzed by supervised multivariate analysis based on Partial Least-Squares Discriminant Analysis and univariate analysis. Samples were grouped according to their median duration of hearing loss. We included the age of patients as a covariate in our models. Statistical analysis and pathways evaluation were performed using Metaboanalyst. Nineteen samples of human perilymph were analyzed, and a total of 106 different metabolites were identified. Metabolomic profiles were significantly different for subjects with ≤12 or >12 years of hearing loss, highlighting the following discriminant compounds: N-acetylneuraminate, glutaric acid, cystine, 2-methylpropanoate, butanoate and xanthine. As expected, the age of patients was also one of the main discriminant parameters. Metabolic signatures were observed for duration of hearing loss. These findings are promising steps towards illuminating the pathophysiological pathways associated with etiologies of sensorineural hearing loss, and hold open the possibilities of further explorations into the mechanisms of sensorineural hearing loss using metabolomic analysis.

Results of bilateral sequential cochlear implantation in prelingualy deaf children

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Objectives: Regardless of the increasing number of studies concerning bilateral cochlear implantation (CI) in children, variable results in speech perception between patients are still reported. Among the reasons that could be associated with the diversity of the results the difference in performance between the ears is considered. The aim of this study is to examine the difference in speech perception between first implanted ear and second implanted ear. **Material:** 63 bilaterally implanted children (sequential procedure) participated in the study. Their mean age at first CI was 1.9 years old and mean age at second CI was 7.8 years. The mean interimplant delay was 5.9 years. The experience with two implants was 6 months. **Methods:** Speech perception ability was assessed with Adaptive Auditory Speech Test. The test was performed in quiet and in noise for each implant separately and in bilateral condition. The test was conducted in anechoic chamber, speech and noise were presented in front of patient (azimuth 0). **Results:** The performance in second implant was significantly worse than the result in the ear implanted earlier. **Conclusions:** The early results of bilateral sequential cochlear implantation show the preference toward first implanted ear.

Roger Dual or Standard adaptive. Which should I choose?

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Background: Roger technology is being used with great benefit in classrooms and homes around the world. It's adaptive gain model means that as background noise levels increase, so

too does the level of the Roger signal, thus providing a favourable SNR even in high noise environments. When RogerDirect was launched in 2018, two adaptive gain models became available for Roger – Standard and Dual adaptive. A study was conducted at Hearts for Hearing in Oklahoma with the objectives to compare speech recognition and subjective preferences of school-age children using hearing aids with standard and dual adaptive Roger systems in a classroom environment. **Material and methods:** Twenty-five children with bilateral, mild to moderately severe hearing loss participated in the repeated measures design to evaluate device differences. Sentence recognition in quiet and in noise using AzBio sentences in diffuse and asymmetrical noise conditions were assessed in a classroom setting with each technology in several conditions to simulate common classroom listening situations. Performance was also assessed in the hearing aid (HA) only condition. Subject preference for Standard adaptive and Dual adaptive was assessed using MUSHRA testing and an AB comparison in loud noise conditions. **Results:** Results showed significantly improved speech recognition with both Standard and Dual systems compared to the HA alone condition. No significant differences in speech recognition in quiet or in noise were observed between Standard and Dual systems in any test conditions. Although participants did not report a significant preference for either system, there was a non-significant trend toward an overall preference for the dual adaptive system in traditional classroom settings. These results suggest consideration should be given for each child on which setting to use.

Searching for genetic background of the inner ear malformation – incomplete partition type 2

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Introduction: Incomplete partition type 2 (IP2) encompasses enlarged vestibular aqueduct (EVA), the most frequently observed congenital inner ear malformation, cochlear hypoplasia and enlarged vestibule. In most EVA/IP2 cases congenital hearing impairment is observed. EVA/IP2 can occur in an isolated manner or in genetically determined syndromes such as Pendred syndrome, branchio-oto-renal syndrome (BOR), Waardenburg syndrome, CHARGE, distal renal tubular acidosis (RTA). Around 25% of EVA/IP2 patients carry two pathogenic SLC26A4 variants, while another 25% have only one variant. In 2017, the CEVA haplotype was identified in the 5' region of SLC26A4. CEVA's function remains unknown, and its frequency has not been assessed in Polish patients. **Objective:** The aim of the study was to identify genetic variants that cause hearing loss in patients with IP2. **Material and methods:** The genetic background of 20 probands with bilateral IP2 was analyzed by next generation sequencing (NGS) using a custom hearing loss gene panel. Presence and segregation of selected variants and CEVA haplotype was verified by Sanger sequencing. **Results:** Genetic testing identified the cause of IP2 in 11/20 (55%) individuals. Two pathogenic variants of the SLC26A4 gene were identified as the cause of IP2 in 5 out of 20 (20%). CEVA haplotype may be the cause of IP2 in 5/8 (63%) patients, who had only one SLC26A4 genetic variant detected in NGS. In one case IP2 were caused by pathogenic variant of the EYA1 gene, related to BOR. **Conclusions:** In our study 10/20 patients carry pathogenic variants in SLC26A4 which also confirms the association of IP2 occurrence with variants in this gene. The identification of CEVA may explain hearing loss caused by IP2 in a large group of patients with only one pathogenic variant found in the SLC26A4 gene. Studies on CEVA allows better understanding of its role in the phenotype. CEVA is a likely pathogenic allele linked to a milder phenotype than pathogenic SLC26A4 variants. Finding a pathogenic variant of the EYA1 gene in a patient with a phenotype matching BOR allows to consider this variant as the cause of IP2.

Self-acceptance of deaf persons and the subjective assessment of benefits and satisfaction with a cochlear implant in adults with prelingual deafness

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Objectives: The subjective assessment of benefits and satisfaction with a cochlear implant (CI) is an essential index of the effectiveness of that medical intervention in different groups of patients with hearing disorders. There are few published studies of the psychological determinants of the subjective assessment of CI benefits and satisfaction, such as personality traits or mental health status.The study aims to assess the self-acceptance of deaf persons in the group of prelingually deaf CI users, and the assessment of CI benefits and satisfaction. The question was if there is a relationship between the self-acceptance of deaf persons and perception of CI benefits and satisfaction. **Material:** The study included prelingually deaf adults aged from 18 to 45 years, using one (81%) or two cochlear implants. The group size was n=84. Age at the time of the first implantation varied within the range of 2–42 years. Age at the second implantation was on average 22 years (SD=6.67). The mean time of cochlear implant use for the first implant was 11 years, for the second 4 years. Studied persons were highly competent in Polish phonic language. **Methods:** The study had been conducted by mail; the rate of returned responses was 32.2%. Self-acceptance of deaf persons and CI satisfaction have been measured using the VAS-type scales, CI benefit has been measured using the Nijmegen Cochlear Implant Questionnaire (NCIQ) that allows for describing the subjective benefits from the CI in three areas: basic and advanced auditory perception, speech, and psychosocial functioning as a (deaf) person with CI, which encompasses self-esteem, perception of limitations in activities and social interactions. **Results:** Self-acceptance as a deaf person was on average 74.5% (SD=25). The mean CI satisfaction was 80%. The prelingually deaf persons experience the largest CI benefits in the area of Activity Limitations (AL – 74.5%) and Social Interactions (SI – 73.6%), the smallest in the field of Self-Esteem (SE – 54.4%). Self-acceptance of a deaf person is related to psychosocial functioning with a

CI, which means that higher level of self-acceptance of a deaf person is linked to perceived higher benefits in these areas. Similarly, higher level of self-acceptance of a deaf person is related to a higher CI satisfaction. **Conclusions:** Self-acceptance of a deaf person is one of the important factors deciding about the CI benefits and satisfaction in the studied persons' subjective assessment. This relationship exists only in the sphere of psychosocial functioning of the prelingually deaf CI users. The prelingually deaf CI users should be offered a psychological intervention to improve their acceptance of self as a deaf person and own deafness. Different forms of psychological intervention may facilitate not only improvement of psychological wellbeing but also increase of effectiveness of cochlear implantation in this group of CI users.

Sound localization in bimodal listeners with optimized stimulation timing of cochlear implant and hearing aid

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Objective: In patients with asymmetric hearing loss, the ability to localize sounds in space is very limited. The main reason is a distortion of binaural processing in the human brain due to the unbalanced transmission of the signals received from both ears to the neural system. In case of severe asymmetric hearing loss patients are often supplied with a hearing aid on one side and a cochlear implant on the other side. By this bimodal stimulation, an improvement of binaural listening tasks is expected. However, listening performance in conditions requiring binaural processing is still far below that of normal-hearing listeners. One of the reasons could be a temporal mismatch of signal processing in the hearing aid compared to the cochlear implant (CI) which may result in desynchronization of the input signals to the neural system when different devices are worn. The goal of the present study was to investigate the mechanisms of binaural hearing regarding sound localization in patients with bimodal stimulation and to compensate for the temporal mismatch. **Material:** In total 10 patients participated in the study. All of them suffered from asymmetric hearing loss and were supplied with a hearing aid and a cochlear implant. **Methods:** Sound source localization tests were performed in an anechoic chamber equipped with an array of seven loudspeakers in the frontal plane. Synchronization of the input signals to the neural system was performed by delaying the signal of the cochlear implant as signal transmission to the neural system via cochlear implant occurs a few milliseconds faster than transmission via hearing aid. Prior to testing the processing time of the hearing aid was estimated based on electroacoustic measurements in a test box. These tests were performed individually for each device in conditions of everyday settings used by the patient. Localization tests were performed subsequently for 5 delay times of signal processing in the CI: delay of the CI signal equal to hearing aid processing time and delay of CI varied between hearing aid processing time by ±1 ms and ±2 ms. In addition, one sound localization test in the daily used bimodal listening condition without delay of CI signal was performed as reference. **Results:** Significant differences were found between wearing the hearing aid only and the bimodal listening condition. In the unilateral condition with hearing aid alone, the angular localization error was at chance level in the majority of the patients. In the bimodal reference condition (without delay) an angular localization error of about 40° was observed. The delay of the cochlear implant signal had a significant effect on the sound localization performance of the patients. In particular, the angular error was lower in all of the delay conditions, between 32 and 36°. However, the effect was small and interindividual variability was large depending on the hearing disorder and the setting of the hearing aid. **Conclusions:** Timing of stimulation does affect sound localization in bimodal listeners. Hence, optimization of stimulation timing in bimodal listeners potentially enhances localization accuracy and lowers bias of sound localization in patients supplied with hearing aid and cochlear implant.

Sound therapy for cochlear implant users with tinnitus

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Objective: Despite the positive effect of a cochlear implant (CI) on tinnitus in many patients, tinnitus remains a problem for a significant proportion of CI users. We investigated the acceptability and effect of sound therapy (a combination of natural background sounds and one concise tinnitus counselling session) on tinnitus and speech perception in CI users who still experienced tinnitus during CI use. **Material and methods:** Thirty-two CI users (32–78 years) participated in phase 1: a test at the clinic to evaluate six background sounds provided by the sound processor. Eighteen out of the 32 CI users participated in phase 2: an optional take-home evaluation of 2 weeks without sound therapy, followed by 5 weeks with sound therapy, ending with an evaluation visit. **Results:** Thirty subjects (93.8%) found at least one background sound acceptable. In phase 2, a small improvement with sound therapy was found for tinnitus loudness, annoyance, and intrusiveness. 50% of the subjects subjectively reported benefit of sound therapy. Especially the sense of control on their tinnitus was highly appreciated. No detrimental effect on speech perception was observed. **Conclusions:** The background sounds were acceptable and provided tinnitus relief in some CI users with tinnitus during CI use.

Speech and Hearing Therapy Students' experiences of online teaching and learning, including online simulated case-based learning during COVID-19

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Background: The COVID-19 pandemic resulted in lockdown which resulted in migration from conventional face-to-face

teaching and learning, to online teaching and learning. However, literature on the student experiences with online teahcing and learning, particularly in the health science professions is sparse. **Objective:** This study aimed to explore the students' experiences of online teaching and learning, including online simulated case-based learning due to the COVID-19 pandemic. **Methods:** This was a descriptive cross-sectional survey amongst Speech and Hearing Therapy students at South African university. An online questionnaire was completed by students using google forms. Data was analyzed using descriptive statistics and thematic data analysis. **Results:** Thirty-nine (25/38) students aged 21–24-years-old (84% female) participated in this study, yielding a 66% response rate. Most participants stayed at home during lockdown, and reported that their learning environment was not conducive to studying; mainly due to poor connectivity issues, electricity load-shedding, lack of support or understanding from family members and having to perform house-chores while they were supposed to be attending class. Additionally, despite being provided with data packages from the university to access online teaching platform Blackboard, and simulated clinical training on the Simucase platform, most students indicated that the data was not enough to cover their learning needs, and had to spend, on average, 20 USD per week to augment the data provided by the university. With regards to Simucase interaction, most (60%) students indicated that the platform provided them with an interactive platform through which they could apply their clinical skills as well as refine their clinical reasoning abilities. Of those who did not use it (16%), most student cited network connectivity as the main barrier to utilizing the platform. **Conclusions:** These findings show that while online teaching may improve access to higher education during pandemics, issues such as access to affordable and reliable internet access, and familial support negatively impacted learning for the students. Systematic solutions such as provision of adequate data and internet access could improve the student's experiences of online teaching. Nevertheless, in cases where face-to-face clinical training is not possible, simulated learning may offer a solution for continued clinical training of future health professionals.

Speech intelligibility in quiet and noise in people wearing hearing aids: A big data analysis

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Objectives: Over 1.5 billion of the world's population require rehabilitation to address their 'disabling' hearing loss. Whereas hearing aids improve speech recognition in quiet, their performance in noisy environment have not been clearly evaluated. Here, we investigate the benefit of wearing hearing aid using a data base of 30,000 subjects. Specifically, we compared aided speech performance of subjects in quiet and noisy backgrounds using deep learning algorithms. **Material and methods:** Subjects from 40 to 109 years old (78±7 years old, mean±SD) with a bilateral symmetric hearing loss were included in the study. Patients were fitted between 2017 and 2021 with standardized protocols realized in 700 Amplifon hearing care centers distributed all over France. Hearing assessments were performed using a pure tone audiometry (PTA) from 125 Hz to 8 kHz. Speech-in-quiet (dissyllabic words presented in free field) and a speech-in-noise recognition tests (HINT sentences in free field, masking noise at 65 dB HL, adaptative procedure) were performed to assess the aided speech performance of subjects. The data were anonymized, centralized, and stored on secure data server. Data processing was carried out using R statistical software. **Results:** The 30,000 patients were partitioned (k-means algorithm, Euclidean distance, 1000 iterations) in 200 clusters according to their pure-tone audiogram. A positive and significant linear relationship was found between aided pure tone threshold in quiet and the mean PTA threshold at frequencies 0.5, 1, 2, and 4 kHz. Positive linear relationship was also found between aided speech performance in quiet and mean PTA threshold. When evaluating the aided speech performance in noise, the correlation was reduced especially in subjects with a mean PTA threshold below 50 dB HL (i.e. mild and moderate hearing loss). Note that hearing aids provide a significant benefit in noise for patients with moderately severe and severe hearing loss (mean PTA threshold above 50 dB HL). **Conclusions:** Our results show that the use of hearing aids improves speech intelligibility both in quiet and noisy environments for people with moderately severe to severe hearing loss. For people with mild to moderate hearing loss, hearing aids improve mostly the speech intelligibility in quiet.

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Study of the central auditory function of children with microcephalia by Zika virus

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Zika virus became an epidemic in Brazil from early 2015, with the first cases of suspected microcephaly caused by Zika virus confirmed in the states of Rio Grande do Norte and Pernambuco. Since then, research has highlighted the need for further investigations to better understand the physiology, symptoms and prognoses in order to better follow up children with congenital Zika virus syndrome. The impact of Zika virus on the development of children with microcephaly is still unknown. Congenital Zika virus infection syndrome has its worst expression when infection occurs in the first trimester of pregnancy. It is also known that the pattern of neurological disorder varies depending on the age at which the mother was infected. However, changes in central functions are expected in most patients with microcephaly and significantly impar neuropsychomotor development, vision and

hearing. So far, studies show controversial results. This investigation was an opportunity to learn about the influence of this neurological condition on the electrophysiological parameters and also made possible to compare the findings of the Early Language Milestone Scale with the results of the electrophysiological exams. This is a descriptive cross-sectional study developed in the Audiology Sector of the two brazilians Universities. The study included 20 children of both genders, composed by the research group, with microcephaly due to congenital Zika virus syndrome and by the control group, comparison group. In this research cortical auditory evoked potential exams were performed and the language development scale, aiming to apply electrophysiological and behavioral measures to assess hearing and language. Longer values were observed in the latency of the N1-P2 components and greater amplitude of the N1 component of the auditory cortical potential in the research group. The scale also showed significant impairment in the linguistic development of the children in the research group. The Smart tools EP software used for neural response analysis showed abnormalities in neurotransmission of frequency spectral characteristics in the auditory pathway in children with Zika microcephaly in frequency domain analysis. The software calculations showed much higher slope and total area values in this population, also suggesting failure in the automated perception control of acoustic changes related to the activity of the N1 component. Electrophysiological and behavioral measurements showed a pattern of atypical development of the auditory and linguistic system in children with suspected microcephaly by Zika virus.

Subjective satisfaction and audiological benefits with an adhesive bone-conduction device in a humid subtropical climate

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Objectives: The main objectives of this study were to evaluate the subjective satisfaction and audiological benefit of an adhesive bone-conduction device, namely the ADHEAR system by Med-El, in a group of older children and adult users with conductive hearing loss. The secondary objective was to observe the acceptance of this adhesive device by this group of users in the humid subtropical climate in Hong Kong. **Material:** The ADHEAR system was on loan from Med-El to 20 participants, 10 aged between 6 and 12 years, and 10 aged 12 years or above, for an 8-week trial period. **Methods:** Speech perception was tested with the age-appropriate version of the Hearing in Noise Test (HINT) in Cantonese Chinese, with and without the ADHEAR system. Spatial sound quality questionnaire was administered. Subjective satisfaction, device usage, and acceptance were evaluated as well. **Results and conclusions:** Audiological benefits with this adhesive bone-conduction device were found comparable between this study and other published studies. Qualitative comments on subjective satisfaction and user acceptance will be further discussed.

Declaration of interest: The study devices were on loan from Med-El to the participants for the specific study period. No other financial interest, whether in monetary terms or in kind, has been provided to the participants or the project team.

Tablet-based hearing screening device for triaging children below 6 years of age in rural communities – Beta validation of prototype

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Introduction: The increase in mHealth based hearing applications provide improved access to hearing services in low- and middle-income countries (LMICs). Use of mobile/tablet based hearing screening in primary health care initiatives is likely to improve access to early identification of disabling hearing loss, especially among children in underserved regions. **Objective:** To beta- validate the prototype tablet-based subjective-behavioural hearing screening measures among children below six years for its accuracy in identifying children at risk for 40% or more hearing loss. **Material and methods:** Tablet-hearing screening device prototype was developed with hearing screening software coded using Python language. Suitable wireless headphones and speakers were finalised as transducers after checking calibration output. The screening tests incorporated behavioral observation and visual reinforcement audiometry and speech recognition threshold (SRT) screening. Stimuli for each test procedure were also developed as a part of this study. For beta validation of the prototype, 25 children were assessed for their thresholds using the standard audiometer and then through the prototype. **Results:** Agreement statistics was used to compare the screening results from the standard audiometer and the prototype for each frequency. Perfect agreement was obtained for all frequencies. Friedman test and descriptive analysis was used to compare the thresholds obtained using newly developed non tonal stimuli and the standard warble tone thresholds. On comparison, threshold obtained using non-tonal stimuli was appropriate and can be used as alternative stimuli for pediatric behavioral hearing screening. Results of speech recognition threshold screening revealed that presentation level of 5 dBSL of warble tone would be sufficient to obtain 50% recognition. **Conclusions:** The prototype was found to be satisfactory in identifying children who are at risk for 40% or more hearing loss. However, scope for improvement in device interface was also identified.

Telepractice implementation readiness and planning assessment in public-sector using mixed methods

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Need: A systematic needs and planning assessment is considered critical prior to large scale program implementation of new interventions (Ekeland et al, 2010; Kidholm et al, 2012) to avoid costly implementation errors (AlDossary et al, 2017) A comprehensive tele-practice model of screening, identification and rehabilitation of children below 6 years with hearing and speech-language disorders is proposed in Tamil Nadu Towards this, a situational analysis was undertaken

to understand the perceived needs and readiness for telepractice integration. **Aim:** To understand the existing needs and assess telepractice readiness among various public-sector stakeholders involved in identification and rehabilitation of children with disability using mixed methods approach **Method:** Cross-sectional design using mixed methods including Focus Group Discussion (FGD) and Semi-structured interviews (SSI) of various stakeholders and geospatial mapping. Study site: Two representative rural districts in South India, Tamil Nadu, having nearly equal population, area and socio-economic conditions were selected to conduct the study. **Material:** Purposive homogeneous sampling was used for FGDs and Maximum variation sampling was used for SSIs Fathers and mothers of children with disability under 6 years of age, and various service providers working in public-sector services participated in the study. Procedure: Guide development – The Bowen's feasibility framework was used as the primary framework (Bowen D.J., et al., 2010) and relevant attributes from various telemedicine frameworks (Addotey-Delove M.N., et al., 2020; Kiberu, et al., 2019; AlDossary et al., 2017; Mauco, et al., 2018) were mapped to these constructs. The interview guides were developed based on this framework. Data collection: The FGDs were conducted in-person in the rural community, and the SSI was conducted in-person or through a secure video-conferencing platform depending on the participant's convenience The FGD and SSI were audio recorded with prior written consent of all participants. For the geospatial analysis, the address of all enumerated children with disability below 6 years of age and service providers (centre and staffing) were obtained for the study sites All public-sector service centres and providers were included Analysis: All recordings were verbatim transcribed and uploaded in NVIVO software v. 12. Each transcript was coded and themes were identified using a deductive approach. For geo-spatial analysis, the geo-locations of providers and patients were obtained using Google Maps platform with latitude and longitude information. Data was imported to a web-based GIS analysis software – TNG is to obtain buffer maps, distances and spread maps. **Results:** FGDs were conducted on four groups of mothers, two groups of fathers, two groups of anganwadi teachers and two groups of primary and secondary government teachers SSIs were conducted with 3 ASLPs, 2 welfare officers and 5 special educators. Parental perceptions on availability and accessibility of diagnostic and rehabilitation facilities, barriers and challenges faced in seeking care, as well as satisfaction with quality of care were obtained Caregiver's comfort and agreeability for telepractice, their intention to try and perceived fit of telepractice was identified. The service providers perceived the currently available services for hearing and speech-language disorders to be inadequate and were ready to explore telepractice Yet, they perceived a need for training, capacity building and more community engagement before implementing such services. The visual map of geographic distribution of persons with disability and all service centres in the selected districts revealed regional disparities in availability of services, non-availability of ASLP staffing and the average distance travelled by patient to avail diagnostic and rehabilitation services in these districts. **Conclusions:** The situational analysis informed us about the key grass root level personnel who can be engaged for telepractice, parental and service provider apprehensions towards telepratice and suitable locations for integrating telepractice in the community.

The accuracy of parental suspicion of hearing loss in children

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Objectives: Parental suspicion of hearing impairment in their children is generally inaccurate. Parents tend to underestimate hearing problems in their children. The aim of the study was to assess the accuracy of parental suspicion of hearing loss in their children. **Material:** This was a population-based, epidemiological study conducted in elementary schools in villages and small towns (below 5000 inhabitants) in all voivodships in Poland. The study sample was 64,750 children (31,387 girls and 33,363 boys) aged 6–13 years old. **Methods:** Pure-tone air-conduction hearing thresholds were obtained at 0.5–8 kHz. Hearing loss was defined as a pure-tone average higher than 20 dB in one or both ears in at least one of the three following pure-tone averages: four-frequency pure-tone average (FFPTA), high-frequency pure-tone average (HFPTA), and low-frequency pure-tone average (LFPTA). Parental suspicion of hearing problems was assessed by a questionnaire. The outcome parameters were sensitivity, specificity, and predictive value of parental perception of hearing problems in their children. **Results:** Positive results of hearing screening were obtained in 16.3% of children. Hearing loss was detected in 6025 children, of whom 1074 (17.8%) were correctly perceived by parents as having hearing problems. Sensitivity was the highest in the case of four-frequency hearing loss, when it was 21.6%. Sensitivity of detecting hearing loss by parents reached above 30% for moderate or worse hearing loss and above 25% for bilateral hearing loss. **Conclusions:** Parents underestimate hearing problems in their children, but they are more able to accurately detect hearing loss if it involves speech-related frequencies and is at least a moderate hearing loss or bilateral loss.

The Adhesive Bone Conduction system, ADHEAR – performance, physics and clinical evaluations

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Objectives: There is a significant need for a well-functioning non-surgical solution for conductive hearing loss, especially in pediatrics but also for adults. An adhesive bone conduction concept called ADHEAR was developed and evaluated. **Material and methods:** The parameters behind an efficient non-surgical bone conduction transmission that works any pressure against the skin were investigated as well as the long term adhesive skin interaction. The objective was also to evaluate the audiometric performance of this innovative arrangement and to evaluate the clinical performance in terms of medical aspects, audiological performance, user-friendliness, wearing comfort and practical handling. The new adhesive bone conduction concept was based on a small non-invasive adhesive attachment placed behind the ear, and a bone

conduction audio processor that can be connected to the adhesive attachment. Audiometric evaluations included free field audiometry and subjective questionaires. **Results:** The results showed that the ADHEAR bone conduction concept performed equivalent hearing stimulation as traditional headband or softband arrangements. The clinical results showed excellent user satisfaction, and the patients are now using it on a regular basis. The first patients that were fitted have now used the concept for more than five years. **Conclusions:** The ADHEAR concept offers significant advantages since it does not include any pressure against the skin and no bulky headband arrangements is required. The concept was found to be a practical arrangement with excellent wearing comfort without any pressure against the skin and was also found cosmetically superior to traditional bone conductors.

The ageing population: Clinical implications on the use of hearing devices

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Objectives: Hearing loss is prevalent among the ageing population. It has also been recognised as one of the risk factors for cognitive decline. Experimental evidence to support the use of any hearing device to alleviate the impact of hearing loss on cognitive decline is limited. Early identification and early intervention of hearing loss among the older adults, by provision of hearing devices and other forms of aural rehabilitation, are however deemed necessary. **Material and methods:** Outreach projects are ongoing among the older adults in the local community. These projects aim to raise awareness on hearing health, provide timely hearing screening, encourage aural rehabilitation, and refer for hearing device fitting when necessary. **Results and conclusions:** Latest results on the community hearing screening project, as well as the corresponding cognitive screening results, will be discussed. Qualitative comments on main barriers and facilitators to hearing device uptake among the participants will also be reported.

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The ASSR – Misleading in the diagnosis of Auditory Neuropathy Spectrum Disorder?

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Objectives: The diagnosis of Auditory Neuropathy Spectrum Disorder (ANSD) is still challenging: because of the fluctuating hearing thresholds, presence of OAEs and very poor or absent Click-ABR-thresholds. Several studies demonstrated good correlations between ASSR-thresholds and pure-tone-thresholds as well as Click-ABR-thresholds in cochlear hearing loss. However, this is ambiguous in patients with ANSD, because there are often mismatches between mostly better ASSR-thresholds and worse, if at all detectable Click-ABR-thresholds. **Aim:** The aim of the present study is to evaluate, if an ANSD may be overseen due to the presence of normal ASSR-thresholds and if ASSR-thresholds correlate with pure-tone-thresholds or with the thresholds of cochlear microphonics (CM) in ANSD. **Material and methods:** 28 patients (4 adults, 24 children) with ANSD were examined. 6 of whom suffered from an aplasia- or hypoplasia of the cochlear nerve. A pure-tone or behavioral audiometry, Click-ABR and ASSR were performed in all patients. 21 patients showed CM in Click-ABR (n=16) or in electrocochleography (EcochG) (n=11). **Results:** None of the patients with ANSD showed completely normal ASSR-thresholds. The ASSR-thresholds were usually better than expected from Click-ABR results. No correlation of the single frequencies of the pure-tone-thresholds and the frequency specific ASSR-thresholds could be demonstrated. However, there were only little differences in the mean or median in all frequencies (mean –1.25–3.5 dB, median –5–2.5dB). There was no correlation between ASSR- and Click-ABR-thresholds. But a correlation between ASSR-thresholds especially at 2 and 4 kHz and Click evoked CM-thresholds in the EcochG was detected (r=0.49–0.69). **Conclusions:** At present there are only few studies concerning the value of ASSR in the diagnosis of ANSD. None of the patients in the present study showed normal ASSR-thresholds, which implies that an ANSD is not likely to be overseen due to the ASSR results. The ASSR by itself is not sufficient for the diagnosis of ANSD, because it's thresholds are usually better than Click-ABR-thresholds. However, the ASSR can be a useful additional diagnostic tool in ANSD which correlates with CM thresholds.

The Bonebridge implant in adults with conductive and mixed hearing loss: Audiological and quality of life outcomes

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Objectives: The Bonebridge system is indicated for the treatment of patients with conductive or mixed hearing loss, whose BC (Bone Conduction) thresholds are not higher than 45 dB HL for 500, 1000, 2000, 4000 Hz in the ear to be implanted. The aim of this study is to measure self-assessed quality of life in adult patients implanted with the Bonebridge system. The secondary objective is to confirm the device's effectiveness in hearing in a population suffering from mixed or conductive hearing loss. **Material and methods:** The adult patients with mixed or conductive hearing loss were implanted unilaterally with the Bonebridge system in the World Hearing Center in Kajetany. The Abbreviated Profile of Hearing Aid Benefit

(APHAB) questionnaire was used to measure patient-reported quality of life before intervention and at 3 and 6 months after activation of the device. At the same timeframes, puretone audiometry and speech audiometry in quiet and in noise were performed. **Results:** Hearing-specific quality of life increased significantly after intervention and remained stable up to 6 months. The mean functional gain after 6 months of device use was 28 dB. Both word recognition in quiet and speech reception threshold in noise were significantly better after 6 months compared to before surgery. Outcomes of aided speech understanding were independent of initial bone-conduction thresholds and equally high. **Conclusions:** Our results show a significant improvement in quality of life with the Bonebridge up to 6 months after activation. Furthermore, the Bonebridge provides significant audiological benefit for patients suffering from mixed and conductive hearing loss in both speech understanding in quiet and in noise. Together with a very low rate and minor nature of adverse events, it is a good solution for hearing rehabilitation in patients with mixed or conductive hearing loss up to a bone conduction threshold of 45 dB HL.

The change in compliance values in the geriatric population

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Introductions: Cell tissues, membranes and organs of the human body age and solidify as a person gets older. As a result, it is expected that tympanic membrane movement decreases and its thickness increases with age. The aim of this study is to investigate the effect of aging in ear membrane compliance values. **Material and methods:** This is retrospective study. Only individuals with a type A tympanogram with an air bone gap of 10 dB or less were included in this research. The immittancemetric test results of 1381 individuals was compared. The individuals in this research were divided into 6 groups (59–65, 65–70, 70–75, 75–80, 80–85, and 85+) according to their age. In this study, we compared the values of compliance between gender, right-left ear and age groups. **Results:** The mean values of compliance between the groups in the study were close to each other. There were no significant differences between the right and left ears of the different age groups ($p>0.05$). Comparing the results of different genders within the age groups, significant results were found in the group aged 59 to 65. Nevertheless, this difference is clinically negligible. There were no significant differences in the other groups ($p>0.05$). When the results of all the individuals were compared according to gender, no significant results were found. When the distribution of the compliance values was examined, the compliance values were found to be in a small range when the minimum and maximum 5% of the groups were not included. **Conclusions:** As the age increased, it was observed that the tympanic membrane shows similar development between the right and left ears. Similarly, no significant change was observed between each age group. Furthermore, a significant difference was not found in compliance values between gender groups. Additionally, it is seen that the dynamic field area decreases with age. For this reason, new scales could be used for elderly individuals.

The clinical effects of steroids therapy in the preserving residual hearing after cochlear implantation with the OTICON Neuro Zti EVO

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Background: A prospective clinical study was conducted to investigate whether two different pharmacotherapy strategies of steroid administration impact hearing preservation in adult patients who underwent cochlear implantation with the Oticon Medical Neuro cochlear implant system. **Methods:** Twenty nine adult participants were included. Pure tone audiometry was performed before implantation, during processor activation and 12 months after activation. There were three treatment groups: (1) intravenous steroid therapy (standard steroid therapy with dexamethasone administrated intravenously at the dose 0.1 mg/kg body mass twice a day); (2) combined oral and intravenous steroid therapy (extended steroid therapy with dexamethasone administrated intravenously at the dose 0.1 mg/kg b.m. twice a day and prednisone (orally) at the dose 1 mg/kg body mass/24 h), and (3) no steroid therapy (a control group). Patients' hearing thresholds before implantation were on average 103 dB HL, 89 dB HL, and 93 dB HL, respectively. **Results:** Deterioration of hearing thresholds was observed in all three patients' groups. Twelve months after surgery the patients with and without steroid therapy had similar hearing thresholds. **Conclusions:** The steroid regimen used in this study did not play a significant role in patients with non-functional residual hearing, who underwent cochlear implantation with the Oticon Medical Neuro cochlear implant system.

The dynamic 'ears' of bees; Towards directional hearing with fully implantable microphones

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Objectives: Understanding the unique properties of the hearing organ of bees provides fundamental evidence on how to obtain and process directional information when only very limited intensity differences and time delays are present. Johnston's organs, on the bee's antennae, have intrinsic directional sensitivity and, in addition, allow for active

scanning movements. We aim to answer the question whether honeybees and bumblebees actively move their 'ears' to obtain optimal directional sensitivity, and we will examine to what extent active 'ears' are able to discriminate acoustical signals produced by their own wingbeat, from sounds produced by predators and other species. **Material and methods:** Coevolution of bees and flowers has generated more than 20.000 species of bees, among which the well- known honeybees and bumblebees. Bees have remarkable auditory skills, based on six 'ears'. Two of them, called Johnston's organs, are located at the second segment of the antennae. They are sensitive to low frequencies (250–280 Hz), corresponding to the frequency of their wingbeats. Despite the small size of bees compared to the sound wavelength, bees can easily be trained to localize artificial sounds. With 'ears' on mobile antennae, bees are able to move their 'ears' closer and further apart, which potentially enhances directional sensitivity for sounds, for example generated by predators or echoes of their own wingbeat. We will study sound discrimination performance using high-speed, high-resolution cameras, in both honeybees and bumblebees subjected to artificial sound stimuli. Experiments are performed in the laboratory and in free field. **Results:** Movies of the movements of the antennae of bees and preliminary data regarding their 'dynamic ears' will be presented. **Conclusions:** No conclusions yet while writing the abstract. In the end, the fundamental knowledge obtained will be used in biomimetic applications aimed at developing fully implantable hearing implants, with a microphone in the earlobe that utilizes active directional scanning.

The effect of the music integrated phonological awareness program on preschool cochlear implant users

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Objective: Phonological awareness is the ability to recognize that words are made up of different phonemes and is the most important of the early literacy skills necessary for the acquisition of reading. Individuals with hearing loss have limitations in understanding the phonological knowledge of speech. For this reason, the reading and writing development of hearing impaired individuals is not at the enough level. A cochlear implant is an implantable device used for patients with severe sensorineural hearing loss who have limited or no benefit from conventional hearing aids. Compared to their normal hearing peers, children using cochlear implants have lower phonological awareness and sound discrimination skills It is known that musical experience has a strong effect on auditory skill development. Music education also provides many different areas such as speech perception in noise, pitch perception, prosody, phonological awareness, reading. Music trainings are also trainings that contribute to the increase of voice discrimination and awareness skills. The purpose of this study was to assess whether deaf children who use cochlear implants benefit from the Music Integrated Phonological Awareness Program. **Material and methods:** Participants of this study were 23 children with cochlear implants (5.46±0.3) and 23 children with normal hearing (5.84±0.7), who have language skills at the level of 5 to 6 years, were included. The aim to observe the effect of the music integrated phonological awareness program on preschool cochlear implant users, and to compare the phonological awareness skills of the study group with the control group after the training. The training was given only to the cochlear implant users group. The program is planned as 10 lessons. Participants were given individualized online training 40 minutes once a week. In the phonological awareness program; first sound awareness, rhyme awareness, syllable awareness, segmentation words into phonemes, isolating beginning-middle and end sounds, and manipulating sounds were performed In music training integrated into the phonological awareness program; tone separation, melodic contour, low-high frequency discrimination, tempo, rhythm patterns, vocal skills were studied. Measures were obtained pre-training and post-training. The TEDIL test was used to measure the participants' language assessment, the Early Childhood Phonological Sensitivity Scale (ECPSS) to measure the participants' phonological awareness, spectral temporally modulated ripple test (SMRT) to measure the cochlear ımplant users' spectral resolution, and mismatch negativity (MMN) tests to measure the cochlear implant users' auditory discrimination ability in this study. **Results:** Music Integrated Phonological Awareness Program led to improvement in phonological awareness skils in cochlear implant users. After training, the cochlear implant users was better phonological awareness skills than their normal hearing peers. Additionally, the amplitude of MMN was significantly increased, and shorter MMN latencies, SMRT ripple values increased, have been found as a consequence of training In the study, it was found that the post-training values were statistically significant compared to the post-training values in all tests applied to the cochlear implant users group ($p<0.05$). **Conclusions:** As a result, we assert that music-integrated phonological awareness training will lead to the improvement of phonological awareness of children using cochlear implants. Music-integrated phonological awareness training may also support both auditory rehabilitation and early literacy skills in 5–6 years old cochlear implant users. This research was not effective in the comparison of other parameters on the perception of phonological awareness for users of cochlear implants (i.e., comparison of unilateral/bilateral cochlear implant or age of implant and duration of implant etc). This study concludes that incorporating music-integrated phonological awareness into auditory training will help children who use cochlear implants.

The effectiveness of ZEN-tones in hearing impaired patients with tinnitus

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Introduction: Listening to music significantly decreases stress-levels and facilitates mind concentration. The ZEN-program is a harmonic sound program that offers a choice of soothing tones and chimes; it may help the hearing aid (HA) users to relax and to concentrate. But the effect of music is quite individual and depends on the preferences of each person. The ZEN-program is based on fractal technology. The term was coined by B. Mandelbrot in 1975 and was derived

from the Latin "fractus" meaning "broken" or "fractured". The fractal consists of self-similar structures but it is not the same, wherever we look we discover new details. Using of fractal technology enables us to achieve the same effect as the music does and to create a self-similar music that keeps on new directions development. **Aim:** The aim is to investigate the effectiveness of ZEN-tones in hearing impaired patients with tinnitus. **Material and methods:** 20 hearing aid users with hearing loss and tinnitus were examined; their age varied from 30 to 69 years old. Group "A" (from 30 to 50 years) included 8 patients (mean age 42±8.1); group "B" (from 51 to 69 years) – 12 patients (mean age 61.1±5.8). The following inclusion criteria were accepted: duration of tinnitus more than one year, no treatment for tinnitus received during the last 3 months, presence of hearing loss and absence of loudness recruitment, the result of the THI questionnaire from 20 to 80 points. The audiological examination included pure tone audiometry, impedancemetry, speech audiometry. Design: the 1st check-up: audiological examination, filling out questionnaires, HA fitting; the 2nd check-up (1 week later): HA re-fitting (in the case of need), turning on the ZEN-program, the rankings of tones, the connection selected ZEN-tones; the 3rd check-up (2–4 weeks later): patient's history taking about the experience of using ZEN-program, questionnaires re-filling; the 4th check-up (1 month later): the patient's interview about the experience of using ZEN-program, questionnaires re-filling; the 5th check-up (1 month later): the patient's interview about the experience of using ZEN-program, questionnaires re-filling, the final audiological examination. **Results:** The mean duration of tinnitus in patients of group "A" was 8.1±4.9 years, group "B" – 6.1±3.7 years. In 63% of patients, the frequency of tinnitus corresponded to the area of maximum hearing loss on the audiogram. During the evaluation the majority of patients have shown the gradual decrease of number of points in the THI questionnaire that was mentioned as the grade of tinnitus-associated problems reduction. Only in two patients of group "B" the number of points increased by the end of the study. In group "A", the differences between the results of the 1st and 5th survey were significant (p=0.01). In group "B", these differences were not significant (p>0.05). **Conclusions:** The problems, associated with tinnitus reduced in 90% of patients due to ZEN-program using. With an increase in the number of points in the initial THI questionnaire, the probability of a positive effect of fractal tones decreases. The younger were patients, the better therapeutic effect of using ZEN-tones was registered. Negative effects of ZEN-program using were not identified.

The Influence of Cochlear Nerve Deficit Region on the Outcome of Adult Cochlear Implantation

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Background: To analyze the morphology of the cochlear nerve as seen on the temporal bone magnetic resonance imaging (TBMR) and to investigate its effect on the speech perception outcome of adult cochlear implantation (CI). **Material and methods:** Eighty-seven postlingually deafened adults, with no labyrinthine anomalies or cognitive deficits, who were implanted with perimodiolar electrodes from a single manufacturer were included. We reviewed the sagittal view of the TBMR and measured the diameter of the cochlear nerve and its relation to the facial nerve. We also looked for the presence of the 'bud sign' and the 'tail sign' which represents the patency of the cochlear nerve from the round window to the modiolus. **Results:** Recipients with the positive 'bud sign' performed significantly better (71.9±22.2%) than those without (58.7±24.4%) (p=0.02). Recipients with the positive 'tail sign' performed better (68.6±23.4%) than those without (59.8±24.6%) but the difference was not significant. There was a positive correlation between the shorter diameter of the cochlear nerve and the word recognition score (rho=0.23, p=0.04). **Conclusions:** Favorable outcome can be expected in patients with larger cochlear nerve and abundant nerve fibers at the basal turn. This finding could imply that there is a 'cochlear nerve deficit region' which may yield poorer results after CI.

The interaction between auditory, visual and cognitive abilities in normal-hearing and hearing-impaired adults

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Objectives: Cochlear implantation is the standard-of-care for individuals with severe to profound hearing loss. Although cochlear implants (CI's) can improve the participation in daily life, a large variation in the benefit obtained from CI's has been reported, especially pertaining to speech understanding. It is suggested that the variation in CI outcome may not solely be due to peripheral auditory factors. Speech understanding is considered a multisensory process, whereby visual information from mouth movements and face expressions is integrated with auditory information in order to increase intelligibility. Besides auditory-visual integration, also cognitive functions (i.e. top-down processes) are involved in the process of speech understanding. More specific, working memory, processing speed, selective attention, and cognitive flexibility and inhibition are required for speech processing, especially when a speech signal is distorted due to background noise, hearing impairment or listening through a CI. The aim of the current study was to unravel the fundamental role of the Auditory, Visual and Cognitive abilities (AVC-abilities) in speech processing in normal-hearing and hearing-impaired individuals. In particular, the specific contribution of these abilities to speech understanding and the interaction between these AVC-abilities were investigated. **Material and methods:** Three groups of subjects participated in this study: (1) normal-hearing adults, (2) adults with moderate to severe hearing loss who are using hearing aids, (3) adults with a post-lingually acquired severe to profound hearing loss with CI. It was aimed to include 30 participants per group. All participants were matched for age, gender and educational level. An AVC-test protocol was set up to investigate the AVC-abilities behaviorally. The auditory test battery consisted of pure-tone audiometry, speech audiometry in quiet and in noise. For evaluation of the visual speech processing abilities, the Test for (Audio-)Visual Speech Perception

(TAUVIS) was used. The cognitive test battery consisted of the subtest 'Repeating Digits and Letters' from the WAIS IV-NL for evaluation of working memory and processing speed. For measuring selective attention, and cognitive flexibility and inhibition, the subtest 'Letter Detection' from the Cognitive Test Battery for Seniors and an auditory Stroop test were used, respectively. Furthermore, the subjective impact of hearing loss on quality of life was investigated using the hearing-related quality of life questionnaire for Auditory-VIsual, COgnitive and Psychosocial functioning (hAVICOP). **Results and conclusions:** This study aimed to investigate the interaction between auditory, visual and cognitive abilities in three groups of subjects with a distinct hearing status. As such, more insight in the different abilities contributing to speech processing can be provided. Currently, data collection is still ongoing, and the results will be presented at the World Congress of Audiology 2022.

The need for multidisciplinary personalized medicine in tinnitus management

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Due to the strong variety of etiologies, patients with tinnitus constitute a very heterogeneous population. Therefore every patient with tinnitus has its unique 'tinnitus profile' which provides guidance towards the most appropriate therapeutic intervention for that specific tinnitus patient. A thorough anamnestic procedure as well as ENT and audiological investigations are essential in the guidance towards proper treatment of tinnitus patients. In order to provide effective care towards the patient, assessment and treatment is required to be performed by a multidisciplinary approach. Yearly approximately 1500 patients consult the University Hospital Antwerp (UZA) with tinnitus as their primary complaint. The Tinnitus Treatment and Research Centre Antwerp (TINTRA) of the UZA comprises a multidisciplinary team of around 30 medics and paramedics. Our group has published more than 150 tinnitus-related peer reviewed articles concerning tinnitus management, neural correlates, therapeutic interventions, etc. making tinnitus one of our main expertise topics. The current presentation will provide insights into the assessment of tinnitus patients on a multidisciplinary level in order to make up the individual tinnitus profile including the influence of possible underlying pathologies, comorbidity with anxiety/depression, somatic influences and coping strategies of the patient. With the tinnitus profile in mind, proper treatment should be provided. A wide range of tinnitus treatments are available such as Tinnitus Retraining Therapy, Cognitive Behavioural Therapy, hearing solutions, physiotherapy, pharmacotherapy, neuromodulation. The state-of-the-art of current treatments will be described in relation to the tinnitus profile emphasizing the need for personalized medicine in tinnitus management.

The new international best practice guidelines for adults with severe to profound hearing loss

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Objectives: An estimated 87 mln people worldwide have severe and profound hearing loss. Evidence shows that for the appropriate candidates, there are large, life-changing benefits from cochlear implants, the magnitude of which cannot be achieved using hearing aid technology alone. Despite this, only around 7% of adults in the U.S. and the UK, with qualifying hearing loss go on to receive a cochlear implant. That means that a large majority of adults with severe and profound hearing loss will continue to use hearing aids for the foreseeable future. Despite this the evidence which underpins best practice for these adults is weak. To address the problem of best practice for hearing aids and severe and profound hearing loss, a group of international experts have come together to develop practical guidelines. The expert group identified unique needs and special considerations for best practice in the audiological management of clients with severe and profound hearing loss. Experts included researchers, academics, teachers of audiology and important audiologists in clinical practice. In developing best practice guidelines, the need for stronger research was found and gaps in the evidence were identified. The guidelines give audiologists practical recommendations that can be immediately implemented in their practice. **Material and methods:** To define best practice the working group used a two-stage approach: (1) use evidence where available, and elsewhere (2) provide the consensus advice of the expert panel. The aim was to develop practical guidelines based on existing evidence and not a systematic review. Evidence-based practices are recommended where possible and in the case of insufficient scientific evidence then recommendations based on expert advice is provided. The aim is to inform best practice in hearing care and improve outcomes for adults with severe and profound hearing loss. **Results:** The resulting best practice guidelines were published online at the end of December 2020: Turton L., Souza P., Thibodeau L., Hickson L., Gifford R., Bird J., Stropahl M., Gailey L., Fulton B., Scarinci N., Ekberg K., & Timmer B. (2020), Guidelines for best practice in the audiological management of adults with severe and profound

hearing loss, Seminars in Hearing, 41(3): 141–245. https://doi.org/10.1055/s-0040-1714744. The guidelines include 153 recommendations for best practiced based on current evidence. The topics covered are include audiological assessment and psychosocial needs, selecting hearing aids and wireless microphones, to the referral for cochlear implants. The relevance of other implantable technologies is also discussed. The recommendations highlight when onwards referral for specialist care by otologist, psychologist or other rehabilitation is indicated and the special considerations needed in tinnitus management when severe and profound hearing loss is present. It closes with a discussion of the challenge of outcome measurement for this group and how to approach long term ongoing care. **Conclusions:** This presentation will focus on the audiological management of adults with severe and profound hearing loss who use hearing aids. Some of the guideline's key recommendations for audiological management will be highlighted. Despite the challenges facing these adults, the aim is to open up new opportunities in care which can improve the quality of audiology provided to these clients. These recommendations have the potential to improve audiological outcomes and quality of life for adults with severe and profound hearing loss.

The relation between hearing status, cognition and listening effort in adults with and without tinnitus

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Objectives: Chronic tinnitus can result in comorbid distressing symptoms, one of which is related to impaired concentration attributable to difficulties with speech understanding in various listening conditions. In this respect, literature stated that non-auditory central aspects, such as working memory and selective attention, may influence hearing and speech understanding in several listening situations. Therefore, speech intelligibility may become more effortful for subjects with tinnitus because their cognitive reserve is reduced by it. Indeed, a pilot study performed by the authors showed significantly more listening effort in normal-hearing young adults with tinnitus compared to a control group (Degeest et al., 2017). It was hypothesized that an attention shift towards tinnitus and an extra load on working memory may reduce cognitive capacity when performing several tasks. Although this study was the first of its kind, it was limited by the lack of using standardized cognitive tests to support this hypothesis. Hence, a recent study pertaining to the impact of tinnitus on cognitive performance and listening effort in normal-hearing young adults showed that selective attention deficits in subjects with tinnitus may be an important factor that affects the amount of listening effort (Degeest et al., 2021). The general goal of this study was to further investigate the effect of chronic tinnitus on cognitive functions and listening effort on the one hand and the relation between cognitive performance and the amount of listening effort on the other hand. Besides, the age and hearing status of the participants were taken into account as potential influencing factors for the amount of listening effort. **Material and methods:** Thirty adults with chronic tinnitus (13 females and 17 males) and thirty adults without tinnitus (15 females and 15 males), aged between 20 and 63 years, were included in the study. Hearing status was evaluated using tympanometry and pure-tone audiometry. Subsequently, a behavioral dual-task test was used to evaluate listening effort in different listening conditions (i.e. favorable and unfavorable listening conditions). A primary speech-recognition task and a secondary visual memory task were performed both separately and simultaneously. Further, verbal working memory, processing speed, selective attention, and cognitive flexibility and inhibition were evaluated. In addition, several questionnaires were administered, whereby for the tinnitus group the Dutch Tinnitus Handicap Inventory as well as the Tinnitus Functional Index were used to evaluate the influence of tinnitus distress on the amount of listening effort and cognitive performance. **Results:** Descriptive parameters were established for the hearing assessment, questionnaire outcomes as well as for the outcomes on the dual-task and cognitive tests. Multiple regression models were conducted to evaluate how subject's characteristics as well as performance on the cognitive tests affect listening effort scores. Preliminary data suggests that the presence of tinnitus, age and hearing status on the one hand, as well as selective attention and cognitive flexibility and inhibition on the other hand are major contributors to the listening effort scores, especially in favorable listening conditions. The results will be presented at the conference. Conclusions: Results regarding cognitive functioning including listening effort can provide information over and beyond the standard audiological test battery in patients with tinnitus, as well as can be used in the counseling or within therapeutic interventions of patients with tinnitus.

The spectral shape of stimuli, using for aided free field ASSR: Real ear measurements' results

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ASSR (Auditory Steady-State Responses) is an objective hearing diagnostics method, based on the registration of auditory evoked potentials in response to modulated stimuli with their automatic analysis. The main benefit of this method is the frequency specificity, which increases its importance in pediatric audiology. The interest to electrophysiological methods has increased in recent years because of necessity for the objective evaluation of amplification outcomes in infants and children with additional disabilities. Methods of aided ASSR registering in the free field were particularly proposed. For increasing the sensitivity of such methods, it's important to get information about the spectral shape of ASSR stimuli, their changes in open ear and after hearing aid (HA) processing. In present study we evaluated modulated tones with the 40 Hz modulation frequency. For carrier frequency of 0.5 kHz we choose the exponential modulation (AM2), for 1 kHz – AM2 and frequency-specific chirp, for 2 kHz and 4 kHz – frequency-specific chirp. Stimulus intensity in free field was 55 dB HL. Stimulation was provided using "Neuro-Audio" system, and real ear measurements – using Affinity 2.0 system. Three steps of measurements were performed: (1) Measurement of the source signal in the referent point of the free field. AM2-stimuli characterized by a narrow shape and the sharp peak, which was accurately appropriate to the career frequency. Chirp tones had more a wide shape, and there was a plato or slight rising to the higher frequencies

at the most amplitude region. The central part of plato (or rising) was centered at the career frequency. (2) Open ear measurements were performed for seven children between 1 and 7 ages. Changes were typical for all children. For the 0.5 kHz, peak movement to 0.6 Hz without the shape changing. For 1 kHz, 5 dB amplitude increasing (AM2) and 3 dB decreasing (chirp). For 2 kHz, peak movement to 2.4 kHz, its sharpening and 3 dB amplitude increasing. There weren't any significant changes of stimulus at 4 kHz. (3) Measurements of stimuli after HA processing. Seven children in age from 1 to 7 years with moderate and moderately-severe sensorineural hearing loss and accurately fitted HA were included. Three HA fitting modes were evaluated: (a) WDRC, digital noise reduction is switch off; (b) linear gain, digital noise reduction is switch off; (c) WDRC, digital noise reduction is switch on. Omnidirectional microphone mode had been selected in each case. Changes for 0.5 kHz: the same amplitude in (a) and (b) modes, 6 dB less in (c) mode; the least noise amplitude was in (b) mode ($p<0.05$). Changes for 1 kHz (AM2): difference in peak amplitude didn't exceed 2 dB between modes; less noise amplitude was in (a) and (b) modes ($p>0.05$) Changes for 1 kHz (chirp): difference in peak amplitude didn't exceed 2 dB between modes; the least noise amplitude was in (b) mode ($p>0.05$) Changes for 2 kHz: difference in peak amplitude didn't exceed 3 dB between modes; the least noise amplitude was in (b) mode ($p<0.05$). Changes for 4 kHz: the same peak amplitude in (a) and (b) modes and 4 dB less in (c) mode; the less noise amplitude in (a) mode ($p>0.05$). **Conclusions:** (1) Stimuli using during free field ASSR tend to be changed in the child's open ear. (2) The optimal HA settings for aided ASSR testing (using mentioned stimuli) are: switched off digital noise reduction, linear gain during 0.5 kHz, 1 kHz and 2 kHz testing and WDRC during 4 kHz testing.

The use of assistive listening device in enhancing auditory processing abilities in Chinese children with dyslexia

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Objectives: This study aimed to investigate the intervention efficacy of an assistive listening device in enhancing auditory processing abilities in Chinese children with dyslexia. **Material:** Auditory processing abilities were assessed by the Cantonese Hearing-in-Noise Test and the Cantonese Tone Identification Test. The assistive listening devices used were the Phonak Roger system. **Methods:** This study used a double-blind mixed design. Seven-two Chinese children with dyslexia participated in the study. Their age ranged from 7–12 and there were 32 boys and 40 girls. They were assigned to the intervention group and the control group randomly. All subjects completed the auditory processing tests at 2 time points: at baseline and after using the assistive listening devices for one academic year. The intervention group used devices with real settings while the control group used devices with sham settings. **Results:** The participants' auditory processing abilities in terms of listening in noise and tone identification were significantly poorer than the norm obtained in children without dyslexia. Auditory processing abilities improved in both groups after one academic year. The amount of improvement in auditory processing abilities in the intervention group was significantly larger than that in the control group. **Conclusions:** Results suggested that the use of assistive listening device in class for one academic year might improve auditory processing abilities in Chinese children with dyslexia.

Total and partial ossiculoplasty in middle ear malformations: Audiological results

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Objective of the study was to assess audiometric results following ossicular replacement surgery in patients with congenital ossicular middle ear disorder with normal external ear. A retrospective review was performed on 40 patients with unilateral or bilateral congenital middle ear malformations and normal external canal who underwent exploratory tympanotomy with ossicular chain reconstruction using TORP (n=26 patients) or PORP (n=14). Demographic data, clinical data, audiometric data and intraoperative findings were collected. Audiological evaluations before, 12 and 24 months after surgery were analysed. Functional ossiculoplasty for patients with congenital middle ear malformations can provide acceptable hearing outcomes.

Treatment of the hearing loss in patients with Ehlers-Danlos syndrome – presentation of 2 cases

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Introduction: Ehlers-Danlos syndrome is a group of genetic connective tissue disorder. It affects 1 in 2500–10 000 individuals. The hearing loss in patients with the syndrome is not usually described as a basic or even additional issue, but it has been reported in a couple of scientific publications. **Aim:** The report is to present detected causes of hearing loss, and treatment possibilities as well as postoperative results of the applied treatment in patients with Ehlers-Danlos syndrome. **Material:** The author presents two pediatric cases of hearing the loss in Ehlers-Danlos syndrome. Both patients had bilateral hearing loss, one a conductive hearing loss, the other one mixed. The patients were operated with adequate methodology. Their hearing was improved in both ears in the postoperative period. **Conclusions:** The authors describe the results of the hearing assessment and discuss the etiology of hearing loss based on the preoperative and intraoperative assessment.

Turkish number test in noise mobile application development and evaluation of its effectiveness

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Objective: Conventional hearing tests do not evaluate hearing functions in noisy environments. However, real life also includes noisy environments. In this context, Digit in Noise, a

hearing screening test in noisy environments, was developed and countries adapted it to their native language. **Aim:** The aim of this study is to improve the Turkish Number in Noise Test and evaluate its effectiveness. Desing: The digits were read to a male speaker whose native language is Turkish. Then a mobile application was developed in accordance with the android operating system. The Turkish Number in Noise test mobile application was evaluated in 100 individuals with normal hearing, conductive hearing loss, S/N hearing loss and mixed hearing loss. **Results:** The mDIN scores of individuals with normal hearing were 39.68±6.82, 36.88±6.31 for conductive hearing loss, 19.40±5.39 for S/N hearing loss and 22.96±4.52 for mixed hearing loss. While there was no significant difference between mGST scores of individuals with conductive hearing loss and normal individuals (p>0.069), there was a significant difference between mGST scores of individuals with S/N type and mixed hearing loss and those with normal hearing (p=0.00). **Conclusions:** When the Turkish Digit in Noise Test scores were examined, the scores of individuals with S/N type and mixed type hearing loss differed from those of normal hearing.

Understanding the causal link between hearing loss and depression in later life and the impact of hearing aids

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Objectives: This study aimed to investigate: (a) whether there exists a causal psychosocial pathway between hearing loss and depression in later life, via socioeconomic position and quality of life, and (b) the moderating effect of hearing aids in reducing the risk of depression among older adults with hearing loss. **Material:** We used the entire dataset of participants aged 50–89 years old (74,908 person-years) from all eight Waves of the English Longitudinal Study of Ageing (ELSA), a large population-based prospective cohort study. ELSA provides a unique resource for exploring issues relating to ageing in England in the 21st century, collecting longitudinal data on the health, social participation, wellbeing and economic circumstances of people aged 50 years and above. **Methods:** We used advanced statistical techniques called dynamic cross-lagged path models (CLPMs) to examine hearing loss and depression's (CES-D) longitudinal relationship over time. The quality of life (CASP-19) and the wealth of participants were examined as the mediator and moderator of this relationship, respectively. Subgroup analyses investigated differences among those with hearing aids within different models of self-reported and psychoacoustically identified hearing loss. All models were adjusted for age, sex, retirement status and social engagement. **Results:** Hearing loss was associated with an increased risk of depression in older adults. However, those in the lowest wealth groups had up to twice the relative risk of developing depression than those in the highest wealth quintiles, as hearing loss disproportionally affected their quality of life. Also, hearing aids had a stronger effect in alleviating symptoms of depression in poorer socioeconomic groups than in wealthy ones. **Conclusions:** Our study has important and novel clinical implications, as it adds to the understanding of the interrelationship between hearing loss and depression and the potential impact of interventions with hearing aids on people's mental health. The existing evidence on the association between hearing loss and depression was conflicting; our study adds to this body of knowledge by identifying for the first time the socio-economic pattern in their relationship. Focusing primarily on the role of the socioeconomic position may satisfactorily explain the causal, temporal and graded relationship between hearing loss and depression over time, which differs according to people's status in the social hierarchy. The early detection of hearing loss and provision of hearing aids may not only promote better hearing health but also enhance the psychosocial wellbeing of older adults, particularly those in a lower socioeconomic position.

Validation of an internet-based digit-in-noise hearing screening test

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Background: The use of digits-in-noise (DIN) tests for clinical and research purposes has increased during recent years. This is partly because DIN tests, amongst other speech-in-noise tests, have the potential to act as an online hearing screening tool. However, such tests need to be validated against the clinically utilised pure tone audiometry before they can be recommended for routine hearing screening in the general population. The Manchester Online Speech-Perception Suite (MOSS) is an online application consisting of a battery of speech-in-noise tests including a DIN test, however, it is yet to be verified for online hearing screening. **Objective:** The aim of this study was to validate the DIN test incorporated in MOSS for use as an online hearing screening tool for adults. The impact of a controlled versus uncontrolled environment and any potential learning effect on DIN-test results were assessed. Design: Sixteen young, native English-speaking adults with self-reported normal hearing participated in the study. Each participant completed the following tests: a) DIN test performed in uncontrolled settings (at home), using personal devices; b) DIN test performed in a sound-proof clinical room using a computer with high-quality sound card and Sennheiser HD600 headphones; c) pure-tone audiometric threshold test (including extended high-frequency audiometry) performed in a sound-proof clinical room. The validation of the online DIN was achieved by comparing speech reception thresholds measured online in an uncontrolled environment with the DIN results obtained in the clinic, i.e. in a controlled setting. Additionally, performance on the online DIN was assessed against clinical audiometric findings for four-frequency and for extended high-frequency pure-tone audiometric threshold averages. **Results:** There was no significant difference between the results of the DIN test completed at home and the results obtained in the controlled clinical environment. There was no statistically significant improvement in performance observed between the first and second test result, indicating the absence of a learning effect.**Conclusions:** The online DIN test was found to be robust enough to be completed in an uncontrolled environment with the personal device and headphones/earphones giving results comparable to those obtained in the clinic. Further research is required investigating DIN test benefit as a clinical tool in the screening for hearing loss, as this study provides only preliminary findings from normal hearing individuals.

Verification of direct streaming to hearing aids: A how-to guide to the digital listening environment

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Healthcare technology is becoming more integrated with consumer devices, and hearing health technology is no exception. Wireless hearing instruments are increasingly able to connect to smartphones, including both Apple and Android platforms, either via Bluetooth Low Energy (BLE) or conventional Bluetooth. Streaming capabilities can improve performance in environments where hearing aid users have traditionally struggled, such as telephone calls, and can provide additional performance benefits when coupled with smartphone technologies, like video calls that provide visual cues. This technology is also allowing hearing aid users to connect to other media via their smart devices, such as audiobooks, podcasts, music, or video apps. As hearing healthcare technology and consumer technology become more intertwined, how do we ensure that hearing aid users are receiving optimal benefit in this new Digital Listening Environment?

Hearing aid verification is both part of audiology best practices and has been shown to improve hearing aid user satisfaction, but verification of digital audio streaming presents audiologists with new hurdles not seen in conventional testing scenarios. Specifically, the audio is never externalized by the smart device, rather digital packets are sent from the phone to the hearing aids, these packets are processed by the hearing aids, and the audio is presented to the hearing aid user by the hearing aid receiver. This creates a major challenge to using conventional test box methods to verify the digital listening environment, as the output from the smartphone cannot be controlled via the conventional test box measures.

Thus, verification of the digital listening environment requires an alternative to existing streaming verification methods. Building off conventional verification methods for direct audio input systems, such as remote microphone technology and streaming accessories, we have formulated a new protocol for verifying the digital listening environment that is intended to both accurate and efficient for clinical use.

This presentation will describe in detail this new verification method highlighting two different smart device operating systems, iOS and Android. We will discuss the impact of different streaming connection methods, the impact of operating systems, as well as cover different stimuli types, ultimately providing clinicians with a practical way to verify hearing aid output for the digital listening environment.

VSB as a viable treatment for complex hearing loss: A first comparison

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Vibrant Soundbridge (VSB) is an active middle-ear implant, providing amplification for moderate to profound sensorineural and mixed hearing loss. In the Netherlands, as a result of reimbursement regulations and cost-effectiveness considerations, application of VSB is currently only considered in cases where conventional hearing aids (HA) or Bone Conduction Devices (BCD) are contraindicated or insufficient. This study gives an overview of experiences with VSB in our tertiary outpatient clinic and audiological center, comparing clinical outcomes of a group of VSB patients (N=20) with the results of patients with a powerful BCD (n=25). Our hypothesis was that the VSB would provide more favorable outcomes and a better hearing performance for patients with bone conduction thresholds over 45 dB HL. Results of the comparison indeed show that, even though the included VSB-patients in general have a comparable or larger sensorineural hearing loss, their performance in speech intelligibility and functional gain is on average as good as or better than the results of the BCD-population. Future research should focus on further application of VSB in a broader population, preferably in a randomized controlled trial, to adequately determine its effects in terms of speech understanding, daily life auditory functioning, quality of life and cost-effectiveness.

Zebrafish as a model to decipher the role of tbc1d24 gene in the development of autosomal dominant hearing loss

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Objectives: TBC1D24 genetic variants are causally involved in the development of both autosomal recessive hearing loss, epilepsy syndromes, and autosomal dominant hearing loss (ADHL). So far, our group published four novel ADHL-causative TBC1D24 probably pathogenic variants by performing high-throughput genetic testing in families with ADHL, and more variants are yet to be revealed. In the light of current discoveries, variants in TBC1D24 emerge as a more significant cause of ADHL. In this study we aimed to use zebrafish model for deciphering the pathogenicity of novel TBC1D24 variants. As a background, we investigated the function of tbc1d24 orthologue and its involvement in hearing in zebrafish. **Material and methods:** Different methodological approaches were used in the study, including (i) expression studies by whole mount in situ hybridization (WISH), qPCR on different developmental stages and cryosections, (ii) assessment of the zebrafish ear and neuromast hair cell morphology by high-resolution imaging and (iii) behavioral studies in a developed tbc1d24-deficient zebrafish models (by knock-down or knock-out of tbc1d24) and in overexpression and rescue tbc1d24 models. **Results:** The expression pattern of tbc1d24 revealed by WISH in 24 hours post fertilization (hpf) zebrafish embryos consists of clusters of primary neurons in the brain and spinal cord. Noteworthy is tbc1d24 expression in the sensory cranial ganglia. Interestingly, according to our qPCR data, the highest tbc1d24 expression levels are detected at the very early stage of embryo development (1–5 hpf), during the dynamic cell divisions and cell-fate programming. In the later development, in 3–5 days post fertilization embryos (dpf), tbc1d24 is expressed more broadly

in the brain and neural retina. As this stage, the expression pattern revealed by WISH was in line with levels of mRNA expression measured by qPCR in different organs of dissected larvae. The qPCR data also revealed an expression of tbc1d24 in larval ear. The additional experiments are planned to clarify the details of tbc1d24 expression and function in the ear and adjacent neural ganglia. The morpholino-mediated knock-down and overexpression of tbc1d24 caused no significant ear-specific morphological changes in zebrafish larvae. However, the behavioral studies revealed changes in the locomotor activity upon tbc1d24 morpholino-mediated knock-down at 24 hpf and 5 dpf. Importantly, the detrimental effect of overexpression of TBC1D24 p.Asp185Asn variant on locomotor activity of 24 hpf larvae was detected in rescue experiments. **Conclusions:** Further studies are needed to understand the role of tbc1d24 in the zebrafish ear and nervous system and to decipher the pathogenicity of other TBC1D24 ADHL-causative variants.

ePosters with Short Oral Presentation

ALRs in noise, investigating the optimal recording parameters in school-aged children

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Introduction: In day to day life, children are constantly exposed to noisy situations, such as in the classroom. Although several psychoacoustic studies showed more difficulty listening in noise in children than in adults, very few studies have been conducted with children to explore these difficulties with neurophysiologic measures. One of these measures, the Auditory Late Responses (ALRs), have shown to be sensitive to dysfunctions in central auditory processing of verbal or nonverbal stimuli presented in quiet. Further exploration of parameters of electrophysiological measurements in noise is needed among children**. Objectives:** The goal of this study was to identify the optimal measurement conditions for the development of the protocol leading to recording ALRs in quiet and in noise, in school-aged children. **Methods:** Fifteen children (8–12 years old) were recruited to participate in this study. Children underwent a complete peripheral hearing assessment and ALRs were collected. Each assessment lasted between two and three hours. For the ALRs measures, two types of stimuli – a 1000 Hz pure tone and a verbal stimulus /da/ – were presented with and without noise. The noise conditions comprised the following parameters: (1) two types of noise – a white noise and a babble noise – and (2) three signal-to-noise ratio – +10, +5 and 0 dB. A total of 2400 stimuli were divided into 12 blocks which were randomized and presented to the participants. **Results:** Results showed a reduced amplitude and lengthened latency of the ALRs components in the noise condition compared to the quiet condition. Moreover, the babble noise had a greater detrimental influence on the verbal stimulus than the white noise when compared to the pure tone and the verbal stimuli in white noise. **Discussion:** The results show that the different combinations of parameters have a different impact on speech perception in noise for children. The selection of optimal parameters could lead to development of a clinical tool helping the objective quantification of listening in noise difficulties and therefore guiding therapy and treatment plans for children having difficulties in processing auditory information, particularly in noise.

Bringing it all back home: remote evaluation of speech intelligibility with hearing aids during lockdown

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Objectives: Intelligibility measurements are crucial in the hearing aid evaluation. Covid pandemic related lockdown prevented hearing aid evaluation (including speech intelligibility (SI)) in the laboratory condition. Thus, a solution for the problem of measuring SI remotely, in the respective homes of our hearing aid wearers was developed and tested in the homes of ten experienced hearing aid wearers with two different pairs of hearing aids (HAs). These remote SI results are then compared with laboratory SI results obtained on the same ten subjects in a previous study. **Material:** The golden standard for evaluating speech intelligibility in quiet in Germany is the Freiburger Test. The test includes a number of lists, each comprising 20 monosyllabic words, recorded by a professional male speaker. As a rule, two lists are performed per subject, played from a loudspeaker positioned at 1m distance in front of the subject. During the test, the subject's task is to repeat each word aloud. The tester is present during the test and has to keep track of the number of correct words per list (i.e. open test procedure). Freiburger can be performed unaided, aided and at different levels. **Methods:** The method we developed for performing Freiburger test remotely, relies on the portable loudspeaker from the Toniebox® system. Toniebox system is a child-friendly, portable audio system for playing music and stories. The system can save up to 90 minutes of sound files and is operated by a small figure called Tonie, placed on top of the loudspeaker. Two Freiburger lists calibrated to 65 dB SPL were saved on the Toniebox system and the system was delivered to each subject in a package left at subject's doorstep. The package also included two pairs of pre-fitted hearing aids (HAs A, and HAs B) and a smartphone with a remote fitting App Telecare installed. After receiving the package, each subject was instructed and guided by the test leader via the Telecare App, in order to build the setup and ensure a noise-free SI test. During the test, the test leader was able to mark the correct words by listening to the subject's answers remotely. **Results:** All subjects were able to perform the test at home and gave positive feedback as to the testing procedure. We show that remotely performed Freiburger test results are comparable with the standard lab procedure results, measured for the same group of subjects two months earlier. The impact of the remote procedure on SI results is discussed. **Conclusions:** In a pandemic related lockdown, remotely performed SI tests are a valid method to evaluate speech intelligibility with hearing aids. The same

method has the potential for evaluating sound dimensions such as sound quality and loudness, based on sound files playback at home.

Comparison of the Auditory Processing Domains (APDQ) and Evaluation of Children's Listening and Processing Skills (ECLiPS) Questionnaires

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Objectives: Up to 7 percent of all school age children suffer from issues with auditory processing of information. These children cannot process what they hear in the same way as other children resulting in significant difficulty in an educational setting. Gathering information from parents/educators about the conditions in which these children falter is most often obtained via a questionnaire. Two questionnaires have been used routinely by our department: The Auditory Processing Domains Questionnaire (APDQ) and Evaluation of Children's Listening and Processing Skills (ECLiPS) Questionnaire. Completion of multiple questionnaires is time consuming and not well liked by families. This study allowed us to compare these two commercially available questionnaires in order to determine which provided the greatest degree of specificity in identifying auditory processing disorders as well as co-disorders. We hoped to determine which parent questionnaire aligned most closely with the patient's clinical diagnosis on the variables of Auditory Processing Disorder (APD), Attention Deficit Hyperacidity Disorder, (ADHD), Nonspecific Learning Disability (NO-S) and Language Disorder (LD) as well as final/overall diagnosis. **Material:** Parents were asked to complete two questionnaires as part of our APD evaluation process: The Auditory Processing Domains Questionnaire (APDQ) and the Evaluation of Children's Listening and Processing Skills Questionnaire (ECLiPS). **Methods:** We analyzed data from all pediatric patients who were assessed for Auditory Processing Disorders during the time period July 1, 2018 – July 1, 2019 whose families completed both questionnaires, with a total of 42 patient's data included in this study. Chart review allowed us to identify previous diagnosis of APD, ADHD, No-S and LD. We compared predictability for group performance for each of these variables for both questionnaires. **Results:** Results from parental questionnaires were very reflective of professional diagnosis for these children. Overall, the APDQ had greater predictability for final/overall diagnosis of the patient (88% agreement for the APDQ vs 21% for the ECLiPS). It was also more predictive for APD (68% vs 62%) ADHD (78% vs 47%), No-S (85% vs 56%) and LD (85% vs 35%). **Conclusions:** Obtaining a chart review for these complicated children revealed an essential flaw in our comparison: for some diagnoses, parental report served as the factor that created the diagnosis (i.e., many children had not received formal evaluation for issues such as non-specific learning disability). We believe that education-particularly to primary care physicians/pediatricians is critical in insuring that children receive the assessments required to create formal evaluation and treatment. Based on the results previously presented, our team has adopted using the ADHQ only with our APD assessments. In addition to parents found the APDQ required less time to complete but it more accurately correlated with patient diagnosis for other non-APD variables as well as our diagnosis following APD assessment.

Cortical activation in children with congenital toxoplasmosis during auditory stimuli

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Objectives: We aimed to verify the most effective auditory stimuli for cortical activation in early treated children with congenital toxoplasmosis (CT) compared to typical children. **Material:** children aged up to three months who were diagnosed with congenital toxoplasmosis through the using the Enzyme-Linked Immunosorbent Assay (ELISA) method in which they detected the presence of IgG and IgM antibodies. These children are coming from the Congenital Toxoplasmosis Control Program of Minas Gerais, Brazil, from 2016 to 2018. The control group was composed by typical children whose families agreed to participate in the research. The treatment for these children was based on medical evaluation and indication with sulfadiazine, pyrimethamine and folinic acid. Children with other associated conditions such as prematurity, syndromes, hearing loss and other infections were excluded. The research was approved by the local ethical committee and all families signed a "free and informed consent form" to participate in the study. **Methods:** We performed all measurements with a continuous-wave (CW) near-infrared spectroscopy (NIRS) system (NIRScout, NIRx Medica Systems). Our optical probe allowed 84 channels that covered the whole head, including frontal, temporal, parietal and occipital lobes. The experimental protocol was block-designed with six blocks. Each block had one period of stimulation that varied from 10 to 12 seconds and a resting period of 10 seconds. Each child performed four different auditory stimuli: mother's voice with child-directed prosody, unknown voice with child-directed prosody, recorded voice without child-directed prosody, and mother's voice during reading. We process and analyzed all data with MatLab homemade codes. The preprocessing included removal of channels with low signal-to-noise ratio, motion artifact correction, and band-pass filtering. To verify which brain regions were recruited during each task, we performed General Linear Model analysis with an adaptive hemodynamic response function. Finally, we applied Wilcoxon rank-sum test to compare results across groups. **Results:** We performed NIRS on 61 children with an average age of 54 days, with a minimum age of 17 and a maximum of 94 days. The CT group was composed by 38 and the control group by 23 children. In the control group, among the stimuli there were more channels activated during the mother's reading and the unknown voice with child-directed prosody when compared to the recorded voice

without child-directed prosody (p=0.0280, p=0.0476, respectively). There was no difference between the mother's voice with child-directed prosody and the recorded voice without child-directed prosody (p=0.2296). In the group of children with CT, there was no statistically significant activation difference between the different stimuli (>0.05). These results may suggest that, among the evaluated group, children with CT presented less ability to discriminate the stimuli when compared to typical children. In the comparison between the group of children with CT and the control group, for recorded voice without child-directed prosody stimulus, there was greater activation in the control group (p=0.0296; Ratio 3.3626). There was no significant difference in the comparison of groups for the other stimuli. A more diffuse pattern of activation was identified in the CT group when compared to the control group. One hypothesis for this finding is the presence of cortex calcifications in children with congenital toxoplasmosis, which may recruit more cortical areas for sensory processing. **Conclusions:** In this study, we identified that typical children had greater cortical activation during mother's reading and unknown voice with child-directed prosody. Among children with congenital toxoplasmosis, there was no activation difference between stimuli and there was a more diffuse activation pattern. This study provides a basis for future research to explore the functional role of brain activity in children with CT.

Developing acoustic criteria that reduces discomfort and hearing problems among pre-school children

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Objectives: Over 90% of 4–5-year-old children in Sweden spend most of their awake time at preschool. The rooms are acoustically designed for educational purposes and not adapted to the specific preschool requirements. Also, sounds reaching a child's eardrum are not comparable to an adult's, as higher frequencies are affected differently by the torso, head, pinna and ear canal. Studies on children's perception and behavior support a sensitivity for high frequencies and studies of otoacoustic emissions indicative of hearing damage have further highlighted the risk. The intermittent sound characteristics in preschool may also contribute to an increased risk for hearing disorders, recently observed in a cohort study among preschool personnel. There is a great need to develop acoustic criteria that support preschool activities and child-specific hearing and health. To investigate the risk of noise-induced hearing problems for preschool children, our research team carried out two preparatory studies among preschool children. One among 12 children from two departments at a preschool in 2015, and one among 33 preschool children from six preschools in 2017. **Material and methods:** Noise levels were measured using stationary measurements and personal dosimeters. Hearing function was measured by Distortion Product Otoacoustic Emissions (DPOAE), which detects early changes in the hearing function after exposure to loud sounds. **Results:** The 2015 study showed a reduced function at 6 kHz (right ear) with a mean reduction of 2.59 dB p<0.05, after a day at preschool. Preliminary data from the 2017 follow-up, show a reduction over the week with similar effects sizes as the previous study but with the clearest and significant effects for 3 and 4 kHz (right ear). Pilot studies have also shown that a child dummy head receives up to 10 dB higher amplitudes around 6 kHz compared to an adult dummy head in a preschool sound environment. Given the child-specific amplification, certain higher frequency sounds may be perceived as painful and distressing by children. Initial support for these reactions was given in a qualitative study of 36, 4–6 years old preschool children. Uncontrollable sounds and distressing sounds i.e. angry, loud and scraping sounds were experienced both physically and emotionally painful. The importance of a child's perspective for acoustic interventions at preschools was further shown in a 2016 study where the reduction of noise levels was significantly associated with a 30% (OR=0.69) reduction of children's perception of scraping and screeching sounds. The study also associated scraping and screeching sounds with a 60% reduction of negative emotional reactions and an 80% reduction of stress-related symptoms. **Conclusions:** Taken together, current room-acoustic standards do not fully capture the acoustic needs of the preschool environment, nor that children experience the sound environment differently than adults. The current occupational safety regulations of the sound levels may not provide enough safety for children. There is, therefore, a great need to continue to study how we may prevent the risk of noise-induced stress and discomfort and hearing disorders among pre-school children. The pilot studies have formed a base for a current study that will relate detailed sound measurements from 33 preschools to measurements of around 330 children's perception (validated questionnaire), language (validated test) and impact on hearing (repeated measures of otoacoustic emissions). The aim is to identify child relevant acoustic criteria that may contribute to preventing noise-induced discomfort, stress and hearing disorders among pre-school children and adults. The poster-presentation will describe results from previous pilot studies and the plan for the larger study.

Early intervention after Newborn Hearing Screening test (local community-centered approach)

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Background: Since 2007, newborn hearing screening test has been approved by national health insurance and has been performed on all newborns. Early intervention as well as newborn hearing screening test are important for hearing rehabilitation and language development of children with hearing impairment. Therefore, the purpose of the present study was to analyze the current status of early intervention for children who have been diagnosed with hearing impairment.

Method: The 20 subjects were enrolled from 5611 children who underwent newborn hearing screening test from 2010 to 2017. They had bilateral hearing loss of more than 60 dB and delayed language development. Children with unilateral hearing loss, multiple disabilities were excluded. All enrolled subjects had an examination of newborn hearing screening test between birth and 3 months. Case interview was conducted by verifying content validity with ENT doctor and speech-language therapist. **Results:** After the diagnosis of congenital hearing impairment, 14 of 20 subjects used assistive devices: 4 subjects wearing cochlear implant, 10 subjects earing hearing aid, and 6 subjects wearing no assistive devices. To investigate the current state of early intervention, 12 of 20 subjects were in early intervention and 8 subjects were not in early intervention. We asked their parents about the problems during early intervention rehabilitation: economic problem (50%), lack of auditory rehabilitation programs (30%), and waiting time for the various tests (20%). **Conclusions:** Newborn hearing screening test was very well performed, but there has been a lack of awareness of the early intervention program after the diagnosis of congenital hearing loss.

Effect of rise time of 500 Hz tone pip on auditory brainstem responses thresholds

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Introduction: There are well known positive aspects of using tones pip in ABR threshold studies, as well as the response characteristics mainly depend on the onset phase of the stimulus. The increase in tone burst rise time and duration causes on the one hand a reduction in the stimulus power spectrum width, and on the other hand it causes a decrease in the amplitude and increase in wave V latency. It is also known that too long tone pip rise time may result in a significant decrease in the synchronization of responses from individual auditory nerve fibers, which in extreme cases may lead to loss of response. In tests of the auditory threshold by the ABR method, along with the reduction of the stimulus intensity, the rate of increase of the sound pressure decreases with respect to the effects mentioned above. In threshold tests, the ratio of the amplitude of the wave V to the noise is important and everything should be done to maintain the value of this quotient as high as possible. Since the change in rise time significantly affects the amplitude of the wave V, it can be assumed that when the rise time decreases, the degree of synchronization of the response will increase, and thus the amplitude of the wave V will do so along with SNR value. **Aim:** The assessment the impact of the rise time of a tone pip at 500 Hz on the recording of auditory response of brainstem evoked potentials as a function of stimulus intensity. **Material and methods:** The study was performed in a group of 10 people with a normal hearing, using the Vivosonic Integrity device. The study used a tone pip with Blackmann envelope of 500 Hz for rise times – 0.5, 1, 2 and 4 cycles of different intensities. **Results:** The test results confirmed the known effect of the increase of latency value and decrease in the wave V amplitude caused by the increase in rise time, with the intersubject variability between the effects of rise time on the wave V threshold being observed. **Conclusions:** The obtained results indicate that shortening the rise time of a tone burst with a frequency of 500 Hz below 2 cycles allows to get lower wave V threshold values.

Effectiveness of combination therapy on profound sudden idiopathic sensorineural hearing loss

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Objective: We analyzed the effectiveness of combination therapy (CT) for profound sudden idiopathic sensorineural hearing loss (ISSNHL). **Material and method:** We reviewed 229 patients with ISSNHL and divided these patients into 4 groups according to the degree of hearing loss: moderate (50–70 dB), severe (70–90 dB), and profound (≥90 dB) groups. The therapeutic modalities were systemic steroid therapy (SST) and SST + intratympanic dexamethasone injection (combination therapy). The SST group received prednisolone therapy. The CT group also received ITDI daily. **Results:** Hearing recovery rates in moderate, severe, and profound groups treated with CT were 65.5%, 71.4%, and 71.6% (77/99), respectively. The difference was not statistically significant (p=0.326). However, hearing recovery rates in moderate, severe, and profound groups treated with SST were 65.5%, 55.5%, and 45.6% (77/99), respectively. The difference was statistically significant (p=0.011). **Conclusions:** Combination therapy was more effective for profound sudden idiopathic sensorineural hearing loss in achieving hearing gain than systemic steroid therapy alone.

Factor analysis related to hearing after mastoidectomy with type I tympanoplasty

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Objectives: The purpose of the mastectomy and tympanoplasty is to improve the hearing by removing the middle ear lesion and reconstructing the hearing mechanism. Although previous studies have reported factors related to postoperative hearing improvement, many studies address the limitations of limited data. The purpose of this study is to analyze the factors affecting the hearing outcomes after chronic otitis media to reinforce the problems of the previous study. **Material and methods:** From May 1989 to December 2018, 848 patients with chronic otitis media who had been followed up for more than 6 months after mastoidectomy with type 1 tympanoplasty were selected. The patients were divided into 2 groups based on the last audiometry: Group A (Post-operative A-B Gap ≤10 dBHL) and Group B (Post-operative A-B Gap >10). We analyzed the presence of pre-operative otorrhea, patency of Eustachian tube, external ear canal stenosis, tympanic and middle ear lesions, ossicular mobility, aditus patency, mastoid pneumatization and method of mastectomy for each group to figure out which factors affect the post-operative hearing outcome. **Results:** Of the 848, 289 were male (34%) and 559 were female (68%), and

497 cases (59%) were included in Group A, 351 cases (41%) in Group B. The air conduction hearing and air-bone gap in Group A were 41.5±16.0 dBHL and 19.8±9.0 dBHL, Group B were 49.7±18.6 dBHL and 26.5±10.3 dBHL. Group A has 185 small perforation (37%), 71 moderate perforation (14%) and 241 large perforation cases (49%), and Group B has 81 small perforation (23%), 119 moderate perforation (34%) 151 large perforation cases (43%), respectively. As for the mastoidectomy type, 492 cases (99%) of Group A underwent Canal wall up mastoidectomy, while 5 cases (1%) underwent Canal wall down mastoidectomy, and for the Group B 330 cases (94%) underwent Canal wall up mastoidectomy and 21 cases (6%) underwent Canal wall down mastoidectomy. The ratio between normal or destruction of the ossicles was 471 cases (95%), 26 cases (5%) in Group A and 286 cases (81%), 65 cases (19%) in Group B. 278 cases (56%) of Group A have sclerotic mastoid, while 258 cases(74%) in Group B cases. 277 cases (56%) of Group A have patent aditus, while 106 cases(30%) in Group B cases. 288 cases (58%) of Group A have patent E-tube function, while 146 cases(42%) in Group B. As a results, the ratio of pneumatic mastoid, of small sized perforation, normal ossicular chain, patent aditus and function of the E-tube were significantly higher in Group A than Group B. **Conclusions:** In this study, the factors affecting postoperative hearing improvement were analyzed. The results can be used to predict the postoperative hearing prognosis and to help select surgical treatment.

Focusing on positive listening experiences improves hearing aid satisfaction in experienced hearing aid users

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Objective: When encouraged to focus on positive listening experiences, hearing aid (HA) users are potentially more likely to realize in which situations HAs truly help them and consequently appreciate their HAs more. These benefits can be overshadowed by difficult experiences, which can negatively influence the person's overall HA satisfaction. In this study, we investigated whether focusing on positive listening experiences increases hearing aid satisfaction in experienced HA users. **Material and methods:** Twenty-one experienced HA users were included in this randomized parallel design study. Ten participants were randomized to the control group and eleven to the positive focus (PF) group. The study duration was one month which included a one-week baseline period, three-week post HA fitting period and two laboratory visits. Prior to the first visit, the participants downloaded a smartphone research app and filled out baseline questionnaires related to personality, auditory lifestyle, and satisfaction with their own HAs (IOI-HA & question on overall satisfaction). This was followed by a one-week Ecological Momentary Assessment (EMA) trial, where participants were prompted every two hours to describe the current situation and rate satisfaction with their own HAs and level of difficulty in the situation. At the first laboratory visit, the COSI questionnaire was administered and participants were asked to rate their expectation of the HAs they were about to be fitted with. They were then fitted with Widex MOMENT 440 HAs. Both groups were instructed to wear the HAs over the next three weeks. The PF group was also instructed to report – via the app – every time they have a good listening experience. Two weeks after the fitting, all the participants were prompted by the app to rate satisfaction with the new HAs, as well as answer the auditory lifestyle and IOI-HA questionnaires. During the third week, the participants answered the same EMA questionnaire rating satisfaction and hearing difficulty in the current situation, as during the baseline period. After the three weeks, the participants attended the second visit at the laboratory where COSI follow-up questionnaire and exit interview were conducted. **Results:** The two groups were well balanced on most of the baseline parameters, except for IOI-HA where the PF group scored higher than the control group. The participants in the PF group submitted on average 38 positive reports (range: 11–75) during the three weeks. When comparing the post-fitting IOI-HA scores, the PF group scored significantly higher even when adjusting for the baseline difference. There was not a clear difference in overall satisfaction score between the two groups. The satisfaction scores in auditory lifestyle and EMA questionnaires were significantly higher in the PF group. The COSI degree of improvement and final ability, as measured at the second visit, were higher in the PF group. The number of submitted positive reports was correlated with the COSI degree of improvement score. **Conclusions:** Focusing on positive listening experiences increased hearing aid satisfaction in experienced HA users and larger number of submitted reports resulted in higher experienced degree of improvement. Interestingly, the only score that did not show a significant effect of focusing on positive listening experiences was overall satisfaction. This could indicate that it is easier for participants to reflect on specific listening experiences and rate them, rather than give one overall score. The results of this study point to the importance of asking HA users to focus on positive listening experiences and talk about them. The potential outcome is increased satisfaction and experienced improvement with HAs, consequently leading to more consistent use of the devices.

Hearing loss and tinnitus after ultrasonic scaling: A case report

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Introduction: Sudden hearing loss may be caused by an acoustic injury. The severity of the symptoms depends on: individual sensitivity to noise, its intensity, nature and duration of exposure. Tinnitus is one of early predictors of noise-induced hearing loss. Use of dental ultrasonic scaler may be a potential hazard to hearing of the patient. **Material and methods:** We report 39-year-old man who presented to World Hearing Center with unilateral hearing loss and tinnitus. Symptoms occured immediately after undergoing ultrasonic scaling. Pure tone audiometry showed normal hearing. High Frequency Audiometry revealed right-sided high-frequency hearing loss. The patient was admitted to WHC, appropriate treatment was initiated. After treatment hearing returned to normal. **Conculsions:** Ultrasonic noise exposure may be related to high-frequency hearing loss. Damage to operator hearing can occur through airbone subharmonics of the ultrasonic scaler. Damage to patients hearing can occur through the transmission of ultrasound to the inner ear by the bones of skull. In the case of acute hearing impairment, it is necessary to introduce treatment according to the guidelines of treatment of sudden deafness.

Hearing thresholds in conventional and extended high frequencies audiometry in medical students and their self-reported music-listening habits

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Objective: Young persons are often subjected to harmful noise exposure caused by listening to loud music. Extended high frequencies audiometry (EHFA) is considered as more useful in assessment of early hearing loss than conventional pure-tone audiometry (CA) because higher frequencies are more susceptible to damage than conventional frequency range. The study was carried out to determine the hearing thresholds in CA and EHFA in young adults in relation to their self-reported music-listening habits. **Methods:** One hundred medical students (68 women and 32 men, mean age 24.7±1.3 years) without otologic complaints were enrolled into the study. In all subjects, CA, EHFA and tympanometry were performed as well as a self-reported questionnaire about music listening habits especially loudness and frequency of music listening in personal music players (PMP). **Results:** Audiological examination revealed temporary tinnitus in 26 persons, vertigo in 5 persons, hyperacusis in 5 persons, ear pain in noise in 10 persons and hearing fatigue after noise exposure in 47 persons. In the whole group mean values of air conduction hearing thresholds were within normal limits (less than 20 dB HL) for all frequencies, however the poorest ones were observed at 6 kHz (right ear – 16.6±7.8 dB HL, left ear – 19.5±7.9 dB HL). Hearing threshold at 6.0 kHz ≥25 dB HL was found in 20 cases in right ear and 30 cases in left ear. The mean values for EHFA differed for right ear from 5.9±10.1 dB HL (at 12.5 kHz) to 12.0±15.5 dB HL (at 16 kHz) and for left ear from 5.8±11.1 dB HL (at 12.5 kHz) to 11.1±14.3dB HL (at 16 kHz dB). It was found that group who listen music quietly has significantly lower mean air conduction hearing thresholds in CA at some frequencies, especially at 6 kHz, than those who listen mid- loud and loud, but there was no such differences in EHFA. There were also no significant differences in CA and EHFA mean values of air conduction hearing thresholds between groups by frequency of music listening in PMP. **Conclusions:** In medical students, the significant differences were found in hearing thresholds in conventional audiometry, but not in extended high frequency audiometry, according to their self-reported music-listening habits. These differences were related to loudness, but not to how frequently they listen music in PMP.

Hyperbaric oxygen (HBO) therapy as an effective therapeutic option for patients with severe idiopathic sudden sensorineural hearing loss

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Backgrounds: Idiopathic sudden sensorineural hearing loss (ISSNHL) is one of the diseases whose mechanism is not fully understood and is not yet fully cured. As one of convincing etiology of ISSNHL is cochlear ischemia, HBO therapy is suggested to be a promising treatment for hearing recovery, especially for the patients with severe hearing loss (over 70 dB). **Objectives:** The aim of this study is to demonstrate the effectiveness of HBO therapy for patients with ISSNHL who showed severe hearing loss. **Methods:** We retrospectively reviewed the medical records of patients who were diagnosed with ISSNHL at Asan medical center from January 2016 to December 2017. All the patients enrolled in this study showed over 70 dB HL on the affected ears. Patients in HBO group received HBO therapy 14 times with systemic and intratympanic steroid therapy, while patients in control group received only systemic and intratympanic steroid therapy. **Results:** Total 82 patients (83 ears) were enrolled in this study. 37 patients (38 ears) were enrolled for HBO group and 45 patients (45 ears) were enrolled for control group. There were no differences in baseline parameter between two groups; gender, age, affected side, combined symptoms such as tinnitus and dizziness, initial glucose level and initial hearing. After 2-weeks treatment, HBO group showed significantly improved hearing than control group (28.1±26.9 dB in HBO group and 14.8±13.5 dB in control group in W4FA, $p<0.05$), especially in low frequency (0.5 kHz, 1 kHz, 2 kHz, $p<0.05$). **Conclusions:** From this study, we strongly recommend HBO therapy as initial treatment option for ISSNHL patients who suffer from severe hearing loss or as salvage treatment option for patients who failed from initial steroid treatment.

Influence of hearing aid experience on behavioral and electrophysiological measures of speech detection, discrimination and comprehension

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Objectives: The goal of this study was to investigate the effects of auditory deprivation (untreated hearing loss) and auditory stimulation (treated hearing loss) on different levels of speech processing using behavioral and electrophysiological measures. **Material and methods:** A between-groups design with three groups of older participants was used: (1) participants with a pure-tone average hearing loss of <25 dB HL from 500 to 4000 Hz, (2) participants with mild-to-moderately-severe sensorineural hearing loss but no hearing aid experience, and (3) participants with mild-to-moderately-severe sensorineural hearing loss and at least 2 years of hearing aid experience. In terms of behavioral measurements, speech detection thresholds (SDT), speech recognition thresholds (SRT), and speech comprehension scores (SCS) were measured. In terms of electrophysiological measurements (EEG), speech evoked N100, P300, N400 and Late Positive Complex (LPC) responses were measured. The N100 and P300 responses were evoked using an active oddball paradigm, while the N400 and LPC responses were evoked using audio-visual (bimodal) and audio-only (unimodal) test paradigms. All measurements were performed in the free field in the presence of stationary speech-shaped noise. All hearing-impaired

participants were fitted with hearing aids to ensure audibility. **Results:** Regarding the behavioral measurements, the SDT are expected to be similar across the three groups, while for the SRT and SCS the group with untreated hearing loss is expected to show poorer results. Regarding the electrophysiological measurements, the N100 responses are expected to be similar across the three groups, while for the P300, N400 and LPC responses the group with untreated hearing loss is expected to show smaller amplitudes. No group differences in terms of mean latencies are expected. **Conclusions:** The hypothesized group differences in the behavioral and electrophysiological measures of discrimination and comprehension would be indicative of changes in cortical speech processing due to (lack of) hearing aid treatment.

Influence of tinnitus on sound localization test

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Backgrounds: Tinnitus can be a debilitating condition, that negatively affects a patient's overall health and social well-being. Even moderate cases can interfere with the ability to work and socialize. The purpose of this study was to investigate the influence of tinnitus, whether it originated from right, left, or both sides, on sound localization process. **Material and methods:** From Jan 2019 to Jul 2019, a total 59 chronic tinnitus patients were enrolled in this study. Of 59 patients, we selected 42 patients (23 males and 19 females) whose mean hearing were less than 60 dB HL and whose net average hearing of both sides were 15 dB or less. Fifteen patients complained of bilateral tinnitus, while 14 and 13 patients complained of right and left tinnitus respectively. Sound localization using three different 3-second pure tone sounds (500 Hz at 65 dB SPL, 4 kHz at 65 dB SPL, and 4 kHz at 90 dB SPL) was assessed using an array of 7 speakers at head level separated by approximately 30 degrees. **Results:** There were no significant differences in sound localization ability whether patients complained any type tinnitus. Furthermore, high scores of THI or VAS didn't affect sound localization process. **Conclusions:** From this study, we concluded that even though patients were suffered from severe tinnitus, they might not have difficulties in sound localization unless there is unilateral of bilateral hearing loss.

Language equity: Delay in care of hearing aid provision services to LatinX patients in a pediatric setting

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Objectives: From September 2019 to December 2019, 107 patients received hearing aids at our facility. The average delay between the hearing aid consultation and fitting was 75 days for English-Speaking/Non-LatinX families (ESNL), 110 days for English-Speaking/LatinX (ESL) families and 132 days for Spanish-Speaking/LatinX families (SSL). These extensive delays prohibited us from meeting a national goal in Audiology is to initiate intervention for hearing loss by the time a child is six months of age. **Methods:** While many factors played a role in this delay (with insurance type typically identified as contributor) insurance type (private versus State Medi-Cal) did not account for the total delay between groups. In examining our process, we determined that LatinX families remained on our scheduling work queue for longer periods than our non LatinX patients. While many factors could be responsible for this, we recognized that while outgoing scheduling calls could be made by any member of our scheduling team, Spanish-speaking families were predominately called by Spanish-speaking staff. As not all of our team speaks Spanish, this resulted in a more limited team to reach out to the Spanish-Speaking group than to the English-Speaking Groups. In addition, families waited longer on hold to schedule or reschedule an appointment. Consequently, we attempted to address the delay times by revising the process to having all families called immediately upon receiving insurance approval-bypassing the wait for an outgoing call. **Results**: In March–June 2021 we reevaluated our delay times. Delays were reduced to 46 days for ESNL families, 67 days for ESL families and 56 days for SSL families. We will continue to fine-tune this process as times are still too long for all families and differences continue to exist, but are pleased that a small change to our process has been able to cut wait times for all of the families we serve and particularly for those with the longest wait times. **Conclusions:** We have identified the lack of language equity as a potential barrier and one we can look to remove as we attempt to delay in care. While supports the ability to change a process to increase equity, it also highlights the continued need for us to recruit Spanish-speaking patient access staff-perhaps requiring innovative recruitment strategies to attract the applicants who are not currently considering RCHSD for employment.

Long term results of bone-conduction hearing implant in unilateral hearing loss patients

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Long term results of bone-conduction hearing implant in unilateral hearing loss patients – What is the proper indication for bone conduction hearing implant? **Objectives:** We analyzed the long term results of bone-conduction hearing implant (BCI) in unilateral hearing loss patients and identified the successful factors for BCI. **Material:** We divided bone conduction hearing implant (BCI) patients (BAHA: *N*=29, Bonebridge: *N*=3, Adhear: *N*=1) with single-sided deafness (SSD, *N*=19) and asymmetric hearing loss (AHL, *N*=14) into user group and non-user group. Average following period is 4.9 year after implantation (Range: 1 year to 11 years). **Methods:** We analyzed the audiogram, Korean version of IOI-HA (International Outcome Inventory for Hearing Aids), etiology of hearing loss and daily using time (Data logging). We asked the reason of non-use in non-user group. **Results:** In pure-tone average (PTA) of better ear, the average of SSD group was 13dB and the averages of AHL group were 39 dB (AC), 27 dB (BC). Of the 19 SSD patients, only 4 patients were users (21%) in long term. 6 of 15 non-users (78%) of the SSD patients were explanted, and 3 of 9 implant patients also asked for explantation. Of the 14 AHL patients, 9 were users (64.3%), 5 were non-users (35.7%). 2 of 5 non-users of the AHL patients were explanted. One of non-user underwent cochlear implant after explantation because of progressive

hearing loss in implant ear. Comparing the IOI-HA total scores of the user group, 22 points (*SD*=10.5) of SSD and 25 points (*SD*=2.6) of AHL group. There was not significant difference between SSD and AHL group. But AHL user group reported better scores in terms of "daily use", "benefit", "satisfaction" compared with SSD user group. The daily using time of AHL group was longer than that of SSD group significantly. All of congenital hearing loss patients (*N*=4) were non-users (SSD *N*=3, AHL *N*=1). The main complaint of nonusers was that BCI was not helpful especially in noisy daily life. Other problems were inflammation, sweating, abrupt detachment of implant and feedback. User group satisfied with relatively quiet situation. **Conclusions:** Audiologically, the company's indication for BCI in SNHL is SSD, but long-term follow up results indicate that BCI is more beneficial for AHL patients than SSD patients. Various factors should be considered and BCI should be determined carefully.

Long-term hearing abilities in noise in school-age children with early-childhood otitis media

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Objectives: Several studies have reported long-term negative consequences of early-childhood otitis media (OM) on binaural hearing abilities in noise. However, the origin and severity of these effects are still unclear. The aim of the current study was to investigate these issues. **Material and methods:** Sixty-two school-age children with or without a history of OM participated. At the time of testing, all of them had type-A tympanograms and audiograms in the normal range. Monaural random frequency modulation detection thresholds and binaural tone-in-noise detection thresholds with the noise interaurally in-phase and the tone either interaurally in- or out-of-phase were measured. Based on the results, binaural masking level differences (BMLDs) were also calculated. Furthermore, speech recognition thresholds (SRTs) in the presence of stationary noise or competing speech with or without interaural differences between the target and masker signals were measured. Based on the results, binaural advantage scores were also calculated. **Results:** Compared to the normal-hearing controls, the OM children showed smaller BMLDs but comparable monaural and binaural detection thresholds. Furthermore, children with relatively severe (but not mild) early-childhood OM showed elevated SRTs with and without interaural differences between the target and masker signals and a trend for reduced binaural advantage scores. **Conclusions:** Overall, the current study suggests that early-childhood OM can have long-term negative consequences for subcortical binaural processing and speech-in-noise processing. Furthermore, it suggests that children with a relatively severe OM progression are at risk of experiencing long-term hearing-in-noise deficits, whereas children with a relatively mild OM progression are not.

Maturation in auditory event-related potentials explains variation in auditory and speech outcomes after CI in prelingually deafness children

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Objectives: To explore the relationship between maturation in auditory event-related potentials and auditory and speech function post cochlear implantation (CI) in prelingually deafness children. **Methods:** In this cross sectional study, we prospectively recruited 77 children diagnosed with congenital symmetrical profound SNHL who underwent unilateral CI in the right side. According to the duration post CI, patients were divided into the following groups: 1) 1-year-post-CI group; 2) 2-year-post-CI group; 3) 3-year-post-CI group. In addition to auditory and speech performance, auditory event-related potentials (AEPs) were recorded to analyze the morphology by P1-N1 complex and the maturation of AEPs by intraclass correlation (ICC). **Results:** The postoperative auditory or speech performance in 3-year-post-CI group was significantly better than 1-year-post-CI group. Between 3-year-post-CI group and 2-year-post-CI group, only significant differences were found in auditory performance. There were significant differences in P1 amplitude and latency among groups, yet P1 latency was more highly correlated to variables of chronological age than P1 amplitude. ICC differentiated the 2- and 3-year-post-CI groups from 1-year-post-CI group. The AEP maturation predicted both chronological age and variation in auditory function. **Conclusions:** Except for morphology by P1-N1 complex, the AEPs maturation by ICC served as optional evaluation for auditory and speech function.

Mitophagy decreases in the cochlea of C57BL/6J mice with age-related hearing loss

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Objectives: An increase in mitochondrial damage has been associated with a decline in the ability to mitigate damage through mitophagy in age-related pathologies. The present study aimed to investigate the changes of mitophagy in a mouse model with age-related hearing loss. **Material and methods:** C57BL/6J mice were divided into two groups: young (1 month) and aged (12 months). Hearing tests were conducted by measuring auditory brainstem response (ABR). Mitochondrial DNA copy number, mitochondrial DNA damage, mitochondrial biogenesis, and mitophagy-related genes and proteins were investigated using real-time PCR and western blot analysis. LC3B and mitochondrial marker TOM20 coexpression in the

cochlea were investigated through immunofluorescence imaging analysis. Major players of mitophagy, Parkin and BNIP3, were also investigated through immunohistochemical staining in the cochlea. **Results:** Hearing thresholds were observed to have increased in the aged group. The mitochondrial DNA copy number, PGC-1α, and PGC-1β significantly decreased in the cochlea of mice in the aged group. mRNA levels of PINK1, Parkin, MUL1, Atg5, Atg12, Atg13, NIX, and BNIP3 significantly decreased in the cochlea of the mice in the aged group. The mitochondrial DNA damage significantly increased in the cochlea of mice in the aged group. Protein levels of PINK1, Parkin, and BNIP3, COX4, LC3B, and all OXPHOS subunits significantly decreased in the cochlea of the mice in the aged group. Immunofluorescence imaging analysis of LC3B and TOM20 revealed a decrease of colocalization in the cochlea of mice in the aged group. Immunohistochemical imaging analysis of Parkin and BNIP3 revealed their decreased expression in aged cochlea. **Conclusions:** Our results indicate that reduced mitophagy with aging might be attributed to the cellular changes that occur in aged cochlea in the development of age-related hearing loss.

Musical training in teenagers with Type 1 Neurofibromatosis: preliminary results and electrophysiological correlates

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Background: Type 1 Neurofibromatosis (NF1) is an autosomal dominant genetic disease that affects one in each 2500 individuals and results in important cognitive impairment, such as learning disorders and auditory processing disorders. In a previous study, we found that 70% of NF1 patients presented some deficit in music perception (amusia), mainly rhythmic and associated to pre-attentional electrophysiological deficits detected with Mismatch Negativity (MMN). **Objectives:** In the present study, we investigated how musical training may change music perception and MMN. **Material and methods:** Six teenagers diagnosed with NF1 aged between 12 and 16 years, 4 females and 2 males, with normal audiometric thresholds, were studied. A six-month program of musical training was proposed, directed to rhythmic learning. Assessment battery before and after training included Montreal Battery of Evaluation of Amusia (MBEA) – short version to evaluate music processing; Gaps in Noise test to evaluate temporal auditory processing; and MMN to investigate pre attentional auditory perception. **Results:** All participants showed improvement in temporal auditory processing, with a reduction in mean values of gap thresholds from 10.25 to 5.41 (95% CI=1.77–7.89; p=0.006). From the six teenagers studied, only three presented detectable MMN in the pre-training evaluation. After training, all participants had detectable MMN (95% CI=0.02–0.10; p=0.049). An improvement was also observed in the mean global and specific music perception to melodic, rhythmic and musical memory, though statistically significant to the latest component (95% CI=1.62–0.04; p=0.042). **Conclusions:** Results obtained corroborate our hypothesis that rhythmic music training may result in improvement of temporal auditory processing, and this may be present also in the pre attentional level of auditory perception. This is a pilot study still in course.

NRT based innovative rehabilitation approaches in CI patients

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Objective: Since the first introduction in 1997 Neural Response Telemetry (NRT) became now the most popular objective measurement which is used in daily clinical practice in CI patients. Due to pronounced increase CI patients number worldwide the new selection of tools based on the NRT methodology were implemented in a novel model clinical care of CI patients – CR120 and CR220 intraoperative remote assistants and the new simplified fitting software – NFS. **Aim:** The aim of this study was to confirm that new tools can replace existing bulky equipment; that less overall time and experiences required to complete the standard clinical workflow. **Material and methods:** A prospective between subject comparison study was conducted with 105 test subjects measured with CR120 and 125 subject measured with CR220 and the standard clinical system. The time required for each measurement was noted. Comparison of thresholds for equivalence or difference, and the measurement time were analyzed. Meanwhile 66 patients were fitted with both the NFS and standard clinical software. Duration of fitting time and outcomes were also noted. **Results:** ECAP thresholds were measured and found to correlate closely between the two measurement systems. The time required for the measurements was significantly less with the remote assistant. CR220 Intraoperative Wireless Assistant can be used by operating theatre staff who are already present. Electrically Evoked Compound Action Potential (ECAP) measurements made with the CR220 wireless assistant were found to be equivalent to the Custom Sound system within a clinically acceptable range (±1 current level). A prospective between subject comparison study was conducted with 65 test subjects fitted using NFS and the standard fitting software. Both fitting orders and audiologists were randomized. Auditory performance was analyzed by an expert speech therapist and a performance questionnaire at multiple time points: at initial fitting and at the three/four months fitting, appointment completed by parents. **Conclusions:** The CR120 and CR220 could be safely used to measure ECAP thresholds intraoperatively. Obtained ECAP threshold measurements were equivalent to data obtained with standard clinical system. Measurements with CR120 and CR220 took less time, required more manageable equipment and staff to make measurements. The NFS system also required less time for map creation and fewer audiological skills for fitting the majority of patients. Performance results were on average comparable between groups. In a number of cases the map created with the NFS was the preferred solution. The new clinical care model is a great tool to implement into the daily clinical workflow and can be successfully used in clinical practice.

Phoneme training at home can improve speech recognition in noise in hearing impaired listeners

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Objectives: Previously, we have shown that supervised phoneme training in laboratory conditions has the potential to improve speech in noise reception thresholds in hearing impaired listeners. The objective of this study was to verify the same training method performed on a mobile phone app at home, without external supervision. **Material:** Objective outcome measures used were: Untrained material: Monosyllabic words test in quiet (Freiburger), Oldenburger sentence test (OLSA) – adaptive speech in noise test; Trained material: Phoneme test in quiet, Phoneme test in noise. Method: App-based, self-performed German phoneme training with auditory and visual feedback was used for up to four weeks by fifteen mild to moderately hearing impaired listeners. Objective measures of phoneme recognition in quiet and noise (trained material) and word and sentences recognition in quiet and noise (untrained material) were tested before and after the training period. The subjective experience of the training was investigated using a set of questionnaires. **Results:** Objective measures: subjects improved significantly on both the trained and untrained material. On average, the subjects had a significantly better speech in noise understanding after training, $t(14)=2.561$, $p=.023$, as well as significantly improved phoneme in quiet recognition $z=-2.675$, $p=.007$ with a near-significant improvement in phoneme in noise recognition $z=-1.698$, $p=.089$. There was no difference in monosyllabic words in quiet recognition before and after training. Subjective measures: the majority of subjects agreed that the training was interesting and enjoyable. The training was described as easy to use by most subjects ($n=14$; 93%). The majority of subjects found that the training improved their speech awareness in everyday life ($n=12$; 80%), and an even higher number of subjects would have continued to use the training ($n=13$; 87%). **Conclusions:** Phoneme based training performed at home has the potential to improve speech understanding in noise on untrained material in hearing impaired listeners. The training is well accepted and has the potential to motivate the hearing impaired listener.

Prediction of the EEG for a speech in noise test using an auditory model

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Objectives: Parts of speech signals (e.g. the envelope) can be detected in encephalographic (EEG) measurements. The EEG signal can be predicted using a temporal response function that describes the pathway from stimulus to EEG signal and is estimated previously. The quality of the prediction compared to the EEG measurement changes with the stimulus signal to noise ratio (SNR). Evaluating a range of measurements at different stimulus SNR it is possible to predict the 50% speech intelligibility threshold (SRT50). We predict the EEG signal with the use of an auditory model according to Kates for six different ΔSNR close to SRT50. Is it possible to evaluate if a single EEG measurement belongs to a stimulus above or below the individual SRT50 by comparing it to the six predicted EEGs? **Material and methods**: 26 subjects identified as normal hearing listened to concatenated sentences of a German matrix sentence test at six different ΔSNR, while a 32 channel EEG was recorded. To predict the EEG one model was evaluated per ΔSNR using 128 frequency bands of the auditory model according to Kates and the assigned TRFs across all subjects. Subsequent it was classified if the single EEG belongs to a speech intelligibility above or below SRT50 by evaluating the quality of the six predictions to compared to the derived measurement. **Results:** The accuracy for classifying if one of the 152 EEG signals belongs to a measurement above or below SRT50 was 90.4% (above=85.9%; below=94.8%). For 85.2% it was classified correctly if it belongs to a measurement above, below or close to (±0.5 dB) SRT50. **Conclusions:** It is possible to predict the EEG for a speech in noise test at different SNR with the use of an auditory model. Consequent it can be classified for a single measurement if it belongs to an intelligibility above or below individual SRT50.

Self-rated benefits of auditory performance after Bonebridge implantation in patients with conductive or mixed hearing loss, or single-sided deafness

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Objectives: The Bonebridge (BB) active bone conduction implant can be a satisfactory solution for patients with conductive or mixed hearing loss, or with single-sided deafness. The device was introduced into clinical practice in 2012, and its results so far have been encouraging. The subjective auditory benefit with can be evaluated using a range of different patient-reported outcome measures. The aim of the study was to assess patients' self-reported benefits after implantation of the Bonebridge system in groups with different types of hearing loss (conductive hearing loss, CHL; mixed hearing loss, MHL; and single-sided deafness, SSD) and characterize the relationships between pre-implantation audiometric data, auditory functioning, and satisfaction after implantation. **Material and methods:** The study sample consisted of 81 adult patients with CHL, MHL, and SSD. The procedure comprised pure tone audiometry before implantation, the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire, and a structured interview asking about satisfaction. **Results:** Statistically significant improvements in subjectively perceived hearing after implantation was found in all three groups on the APHAB questionnaire; however, patients with SSD were the least satisfied with their present hearing. No significant correlation was found between pre-operative air-bone gap and APHAB score, nor between bone conduction thresholds and APHAB score. **Conclusions:** Bonebridge implantation is beneficial to patients with both CHL and MHL or those with SSD. In the APHAB questionnaire, no statistically significant differences

were observed between the three groups of patients (CHL, MHL, SSD). Differences were observed in outcomes of the structured interview asking about satisfaction with using the implant: patients with CHL and MHL gave significantly better assessments than those with SSD.

Sex differences and the effect of female sex hormones on auditory function: a systematic review

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Aims: This systematic review aimed to investigate if there are sex differences in the auditory function, and if these differences influenced by the female sex hormones. In addition, it aimed to investigate the relation between fluctuations in female sex hormones (i.e., oestrogen and progesterone) and auditory function of pre-menopausal and post-menopausal women. **Methods:** As most of the studies found in the literature search were observational studies, it may not be suitable to follow the Population, Intervention, Control, Outcome and Study design (PICOS) criteria in developing the review questions as it is for intervention studies. However, Population (P) and Outcome (O) can be used for developing the review question for observational studies. The review protocol is pre-registered in the Prospective Register of Systematic Reviews (PROSPERO; CRD42020201480), and it was performed in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Data Sources: EMBASE, PubMed, MEDLINE (Ovid), PsycINFO, ComDisDome, CINAHL, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL) via Cochrane Library, and scanning reference lists of relevant studies, and internet resources (i.e., Mendeley) were used and studies published between 1999 and 2021, in English, or if English translation were included. The quality of evidence was assessed using Newcastle-Ottawa Scale (NOS). **Results:** Women were reported of having better hearing sensitivity (in peripheral and central auditory system). In addition, women's auditory function fluctuated during the menstrual cycle, where men tend to have more stable auditory function. During late follicular phase, the peripheral hearing was reported to improve, where it decreased during luteal phase. However, the role of oestrogen and progesterone in the central auditory system remains unclear. Women hearing sensitivity tend to rapidly decline soon after the start of menopause. **Conclusions:** The possible effect of female hormones on hearing remains unclear and may needs further investigation. As the included studies highlighted the need to implement a well-designed study in evaluating the influence of oestrogen and progesterone on hearing by including men as control groups, use objective tests to measure hormonal level, and to test participants at different points across the menstrual cycle.

Statistical learning and language development

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Statistical learning refers to the ability to extract repetitive patterns in the environment, in particular, the statistical regularities in sequences of environmental events. This kind of learning is procedural without the explicit knowledge of accumulated experiences and is based on probability. Importantly, environmental regularities are highly relevant for language structure and thus language acquisition largely relies on the ability to extract and learn statistical rules. Perceiving statistical events is relevant for learning phonology and word structure It is also important for the acquisition of syntax and semantics. While listening to the speech in the environment the child is exposed to words and "extracts" their meanings and grammatical forms from the natural contexts. It is plausible that some impairments in language development may be related to atypical abilities to learn statistical regularities. One of the developmental disorders that are manifested in a diminished ability to acquire and make use of language is specific language impairment (SLI). The impairments present in SLI may refer to all aspects of language abilities. Language development is generally delayed among children with SLI, however, the difficulties are not only quantitative in nature. Specifically, the deficits may include phonology, vocabulary, morphology, and syntax. One of the theories that offer an explanation of SLI symptoms is Ullman et all's (2005) Procedural Deficit Hypothesis (PDH). They suggested developmental deficits of brain structures that underlie the procedural memory system. Within this system, a network of interconnected brain regions, including the frontal lobe and basal ganglia structures, underlie processes of procedural learning In the PDH, Ullman proposed that a large number of individuals with SLI could suffer from deficits in this brain network. Indeed previous research findings suggest lower statistical learning abilities among children with SLI Here we present the result of a pilot study, that investigated the relationship between language skills and the ability to learn probabilistic sequences among young children. We hypothesized that children with lower language abilities would manifest a significantly slower rate of learning statistical sequence. Statistical sequences that were exposed to children comprised of visually presented objects of two categories. The first category of objects included abstract nonverbal symbols and the second category included images of animals, which may generate a verbal response. The appearance of each stimulus was probabilistically determined, such that stimulus A was followed by stimulus B with 0.8 probability, stimulus C with 0.2 probability, and so on. Children participated in one-week online training during which they had to complete 5 experimental sessions. They also fulfilled language tasks including verbal memory, syntax, grammar, and comprehension of short stories. The participants were asked to observe sequences of symbols and to decide which of four symbols should appear next. The study included 11 boys and 7 girls, the mean age was M=8.25 (SD=0.77) Statistical learning training implemented online without controlling for performance conditions did not show a significant increase in incorrectness in task performance over the entire 5 measurement days Despite this, correctness the tendency to choose answers that realized the

statistics linearly improved between measurements regardless of the type of stimulus presented, and was statistically significant Mean correctness for nonverbal stimuli was P1: M=0.46, P2: M=0.49, P3: M=0.53, t(858.65)=38.8, p<0.001, and for verbal stimuli P1: M=0.54, P2: M=0.6, P3: M=0.62, t(874.58)=37.2, p<0.001 Interestingly, the level of performance on the language test was a significant differentiator of the correctness of task performance, but only for verbal stimuli Children with high language test scores had significantly higher response accuracy, t(2468.8)=64.4, p<0.001.

Strain-specific changes occurring in animal auditory system after stress

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Background and aim: There is an association between stress and tinnitus, but a causative link has not been evidenced to date. An important step towards understanding the connection between stress and tinnitus is an experimental determination of the biological effects, which stress may have on the auditory system. To address this in vivo and in vitro, we used three different rat strains: two inbred strains (Lewis and Fischer 344) and one outbred strain (Wistar). Because of their genetic heterogenicity, Wistar rats are widely used by the pharmacological industry for drug testing and serve as a control in experimental psychology and psychopharmacology. In contrast, Lewis rats serve as a model of post-traumatic stress disorder (PTDS) while Fischer 344 rats after stress display increased anxiety-related behavior. In humans, both conditions (PTDS and anxiety) are often diagnosed in patients with tinnitus. We reasoned that the detection and comparative analyses of physiological and biological reactions of experimental animals might contribute to a better understanding of the neuronal, immune, and endocrine interplay of the auditory system. **Methods:** We exposed all animals to experimental stress for 24 h. After stress exposure, changes in the auditory system were measured on the functional level using distortion product otoacoustic emissions (DPOAE) and auditory brainstem responses (ABR). In addition, we measured the concentration of corticosterone and tumor necrosis factor (TNF-alpha) in sera of the animals using respective enzyme-linked immunosorbent assay (ELISA). **Results:** We found significant differences between rats regarding ABR thresholds in high frequencies. The control group of Wistar rats had higher thresholds (41.9 dB±12) than Lewis (35 dB±6.3) and Fischer 344 (29.8 dB±4.5). Also, Fischer 344 DPOAE thresholds measured at 2kHz were higher (53.4 dB±10.8) than the thresholds of Wistar (36.9 dB±11) and Lewis rats (36.9 dB±9.3). Immediately after stress, the ABR thresholds measured in low frequencies (0.5 kHz) decreased in Lewis rats (51.8 dB±10.6), whereas the thresholds of Wistar rats increased (58.3 dB±10.3), and Fischer rats remained unchanged (60.8 dB±10.8). At the same time, the DPOAE thresholds measured at 2 kHz decreased in Lewis rats (32.1 dB±6.4) and increased in Fischer (55.6 dB±11.1) and Wistar rats (43.2 dB±11.9). We also determined differences in the concentrations of serum corticosterone between rat strains before and after stress. Unstressed Fischer 344 rats had higher corticosterone concentration (417 ng/ml) than Wistar (202 ng/ml) and Lewis (119 ng/ml). Immediately after stress, the corticosterone concentration increased in Fischer (538 ng/ml) and Lewis rats (144 ng/ml) whereas Wistar rats had decreased corticosterone concentration (170 ng/ml). ELISA indicated that the concentration of pro-inflammatory cytokine TNF-alpha in the unstressed Lewis rats (10 μg/ml) was significantly higher than this in Wistar (3.3 μg/ml) or Fischer 344 rats (0.76 μg/ml). The concentration of TNF-alpha remained unchanged immediately after the stress: Lewis (10 μg/ml), Wistar (3.253 μg/ml) and Fischer 344 (0.98 μg/ml). **Conclusions:** Here, we demonstrated that in the animal model, the reaction of the auditory system to the stress is strain-dependent. The changes affect both the auditory periphery (DPOAE) and brainstem (ABR). Upon exposure to stress, Lewis rats (which serve as a model of PTSD) increased their auditory abilities whereas Fischer 344 rats (which serve as an anxiety-related model) decreased their auditory abilities, similar to the outbred Wistar rats. Uncovering the biological basis underlying the differences in the auditory reaction to stress between the animal strains might advance our understanding of auditory disorders, such as tinnitus or hyperacusis.

Systematic review and meta-analysis of audiological and patient-reported outcomes with the Bonebridge

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Objectives: With the new EU HTA Regulation, the benefit assessment of new therapies is regulated for the first time at the European level. The assessment will take place in parallel with the European regulatory approval process. The objectives are to accelerate the patient access to new therapies, reduce duplication of work, and to harmonize clinical assessments. This means jointly agreeing on which methodological tools are suitable for HTAs, how to deal with different endpoints and how to include different evidence. This work aims to present an example of statistically sound evidence synthesis for medical devices, by the example of a bone conduction implant. To summarize audiological, patient-reported outcomes, and direct comparative evidence associated with the Bonebridge published in the medical literature between January 2012 and April 2021, with the overall goal to provide not only a comprehensive overview on the scientific literature published on the Bonebridge, but also to perform a quantitative analysis & synthesis of the overall benefit and variation in selected clinical outcomes. **Material and methods:** Based on a systematic literature review, 166 publications were identified and of these, clinical outcomes from 104 primary articles (reporting on 1975 placements in 1949 patients) were included and plotted as raw mean unaided/aided or improvement scores. From a subset of 49 publications, meta-analyses were conducted to estimate pooled mean scores across publications. Mixed models and model selection were used to explore the effects of potential demographic and clinical predictors on some outcomes. **Results:** Both, the raw means and pooled estimates from meta-analyses consistently indicated similar average outcomes and levels of variation among studies. Overall, age group (Adults, Pediatrics) and F/U time did not influence any of the outcomes investigated. The type of hearing loss (CHL, MHL, SSD) might have an effect on

speech in noise test results, with CHL patients performing better than MHL or SSD patients. However, these results are based on a low sample size (*N*=8) and should be handled with care. Different testing conditions, e.g., test setup or speech tests were identified as biggest sources of variation in audiological outcomes. Specifically, the results of the meta-analyses were: The pooled mean aided Sound-field hearing threshold was estimated at 29.9 dB HL (95% CI: 27.9–31.9). The average benefit (i.e., functional gain; *N*=34) was estimated at 34.4 dB HL (95% CI: 32.1–36.8). The pooled mean aided Word recognition score at 65dB SPL (WRS65) score was estimated at 85.6% (95% CI: 81.2–90). In patient-reported outcome measures (PROMs), the average aided score of the Abbreviated Profile of Hearing Aid Benefit (APHAB; *N*=11) questionnaire as well as the Hearing Device Satisfaction Scale (HDSS) questionnaire (*N*=4) could be used for meta-analyses. The average aided score of the APHAB was estimated at 25.4% frequency of problems (95% CI: 20.1–30.7) and the average satisfaction score was estimated at 87.7% (95% CI: 81.7–93.8) for the HDSS, respectively. In addition, the daily use of the audio processor could be estimated at 9 hours (95% CI: 5.1–12.4). Direct comparative evidence showed that Bonebridge patients performed significantly better compared to transcutaneous, non-implantable hearing solutions and equally well compared to percutaneous implantable solutions in terms of audiological outcomes. **Conclusions:** Overall, the reviewed literature on the Bonebridge provides compelling evidence for long-term hearing improvement, by means of hearing thresholds, speech in quiet and speech in noise tests, measurable benefit in hearing-related quality of life, accompanied by high wearing comfort and patient satisfaction, as measured by daily use of the device.

Systematic review and meta-analysis of audiological and patient-reported outcomes with the Vibrant Soundbridge

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Objectives: The new EU HTA Regulation, which the EU agreed on 22nd of December 2021 after years of negotiations, provides the basis for binding cooperation between the national HTA authorities of the EU Member States. With the help of HTA, the added value of new health technologies and procedures for patients is assessed in comparison to approaches that already exist. In future, a clinical assessment of data will be carried out at European level as part of the HTA process. Member States are required to take this into account, provided that these data are suitable for the national issue and meet quality requirements. Within the next three years the organizational framework will be set up, and methodological guidance documents will be prepared. This means jointly agreeing on which methodological tools are suitable for HTAs, how to deal with different endpoints and how to include different evidence. With this work we aim to present an example of statistically sound evidence synthesis for medical devices, by the example of a middle ear implant. To summarize audiological and patient-reported outcomes associated with the Soundbridge published in the medical literature between January 1997 and December 2019. The overall aim is to provide not only a comprehensive overview on the scientific literature published on the Soundbridge, but also to perform a quantitative analysis & synthesis of the overall benefit and variation in selected clinical outcomes. **Material and methods:** Based on a systematic literature review, clinical outcomes from 219 primary publications on the Soundbridge middle ear implant system were included and plotted as raw mean unaided/aided or improvement scores. From a subset of 72 publications, meta-analyses were conducted to estimate pooled mean scores across publications. Mixed models and model selection were used to explore the effects of potential demographic and clinical predictors on each outcome. **Results:** Both, the raw means and pooled estimates from meta-analyses consistently indicated similar average outcomes and levels of variation among studies. Overall, pediatric patients and patients with pure conductive hearing loss were associated with better aided results in sound-field hearing thresholds and WRS65 compared to adults and SNHL or MHL patients. The site of FMT coupling had no effect on any outcome summarized here, thus highlighting the surgical flexibility of the middle ear implant system. Specifically, the results of the meta-analyses were: The pooled mean aided Sound-field hearing threshold was estimated at 34.6 dB HL (95% CI: 32.4–36.8). The average benefit (i.e., functional gain) was estimated at 33.9 dB HL (95% CI: 30.5–37.3). The pooled mean aided Word recognition score at 65 dB SPL (WRS65) score was estimated at 79.6% (95% CI: 76.4–82.9). In patient-reported outcome measures (PROMs), the average aided score of the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire resulted in 30.8% frequency of problems (95% CI: 23.2–38.5), whereas daily use of the audio processor could be estimated at 11.9 hours (95% CI: 8.3–15.4). **Conclusions:** Overall, the reviewed literature on the Soundbridge provides compelling evidence for long-term hearing improvement, by means of hearing thresholds, speech in quiet and speech in noise tests, measurable benefit in hearing-related quality of life, accompanied by high wearing comfort and patient satisfaction, as measured by daily use of the device. As the new EU-HTA Regulation focuses on clinical aspects of HTA, i.e., the relative clinical effectiveness and relative clinical safety of a new health technology as compared with existing technologies, this analysis can help to ensure sustainable added value to patients across Europe.

The new coronavirus infection (COVID-19) and hearing function in adults

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Background: COVID-19 has shown to have a high range of clinical manifestations. Among the ENT symptoms, olfactory disorders and nasopharyngitis are the most common. Cases of COVID-19-induced acute sensorineural hearing loss have been described, but literature data concerning long-term impact on hearing status after coronavirus infection are scarce. **Aim:** The aim was to evaluate the effect of coronavirus

infection on the hearing function of adult patients. **Material and methods:** We examined 161 subjects in the period from 2 to 48 weeks after recovery of coronavirus infection of varying severity; 120 women and 41 men from 23 to 92 years (60±13 years). Twenty four patients had the results of a baseline audiological examination before the infection. We performed pure tone audiometry, impedancemetry, speech audiometry in quit and noise, binaural fusion test, dichotic digital test, and cognitive status examination by the Montreal Cognitive Assessment Scale (MoCA). **Results:** Hearing disorders (occurrence or worsening of hearing loss, decreased speech intelligibility, tinnitus) were complained about by 81% of patients, 43% noted memory impairment. According to pure tone audiometry, 24% of the subjects had normal hearing, while 76% had hearing loss (mostly sensorineural) of degree slight to severe. No significant changes in hearing thresholds were found in patients who underwent audiological examination before COVID-19. A type "A" tympanogram in both ears was registered in 107 (66%) patients, there was a wide variation in acoustic reflexes parameters. Disorder of intelligibility of monosyllabic words in quit was revealed in 33% of patients, in noise – in 42%, low indicators in the dichotic digital test – in 54%. MoCA scale values were less in comparison data – 26 points (19 to 24 points) in 71% of patients, indicating cognitive impairment. **Conclusions:** Deterioration of speech test scores in patients after COVID-19 can be both a manifestation of central auditory processing disorders and a consequence of memory impairment, as well as one of the signs of changes in the cognitive status in general. Further audiological follow-up of patients after COVID-19 is necessary to assess the possible impact of the infection on the auditory system in the long-term period.

The role of auditory synaptopathy in the hearing impairment in patients with primary arterial hypertension

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Introduction: Hypertension is a risk factor for Sensorineural Hearing Loss. However, the level of central or peripheral lesion has not been established yet. The gold standard for hearing examination – Pure tone audiometry – is an insensible method in this case. What necessitates the search for the diagnostic of the level of hearing disorders in patients with Arterial Hypertension. **Aim:** To determine the topographic and functional level of damage of the hearing organ in the patients with primary arterial hypertension. **Material:** 35 patients with low-risk primary hypertension with normal hearing threshold and 35 healthy patients studied at Audiology department of the State Institution "The Republican Center for Research and Practice in Otolaryngology", from 2018 to 2019 year. **Method:** mathematical statistics, Student *t*-test, Fisher test. All patients underwent DPOAE, TEOAE, tympanometry and acoustic reflexes, Auditory Brainstem Response, high-frequency audiometry, Word Recognition test, Rapidly Alternating Speech Perception Test, Dichotic Digits Test. **Results:** The study involved 70 individuals an equal men (*N*=38) and women (*N*=32) in the middle age at 35.31±10 years (95% CI 18–55 years). All patients (*N*=70) were divided into 2 groups: 1 group (experience) – patients with hypertension, 2 group (control) – patients without hypertension. It was found that patients of the first group complained of a decrease in speech intelligibility (*N*=30), difficulty in recognizing speech in polyphony (*N*=30), tinnitus (*N*=12), hearing loss (*N*=5). Tinnitus was observed only in patients with decreased diastolic pressure "over deep" according to daily blood pressure monitoring. Tympanogram type A was registered in all the patients in two groups (*N*=70) with bilateral acoustic reflexes. Pure Tone Audiometry and High-frequency audiometry showed any changes only in 1/3 of the studied first group (*N*=9). All patients passed DPOAE or TEOAE with no statistically significant difference between two groups. But the arterial hypertension group showed significantly lower results at 1501, 2002 Hz frequencies by the DPOAE. It was significantly revealed an elongation of the interval I–V ($t \geq 0.95$) with an increase in the amplitude and an increase in the latency of the wave I ($t \geq 0.93$) in the group with arterial hypertension. The I/V wave ratio was more 1 in the first group($t \geq 0.95$). Monosyllabic Speech intelligibility test, Rapidly Alternating Speech Perception Test were 65±5% ($t \geq 0.95$) with an extremely low percentage of passing digital dichotic tests – 25±5% ($t \geq 0.95$) in patients of the first group. **Conclusions:** Arterial hypertension is a systemic disease that causes damage to the organ of hearing at the central and peripheral levels. Auditory Synaptopathy leads in the Hearing Impairment in Patients with Primary Arterial Hypertension. Speech intelligibility tests and Dichotic Digits Test should be used for diagnosing hearing impairment in addition to the standard battery tests.

The threshold dynamics of the auditory nerve electrically evoked compound action potential in implanted children

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Objectives: The method of neural response telemetry (NRT) provides clinicians working with the patient after cochlear implantation (CI) the ability to record auditory nerve electrically evoked compound action potential (ECAP) and obtain the information on the activity of individual groups of spiral ganglion neurons. Due to increased number of very young patients with CI recently NRT-based programming became one of the most important and useful programming methods. **Aim:** To evaluate the ECAP thresholds in implanted patients intraoperatively, as well as 1, 3, and 6 months after the CI. **Material and methods:** 50 implanted with Nucleus CI systems – CI512 Profile and CP900 (Cochlear, Australia) patients aged from 1 to 4 years with a diagnosis of bilateral severe-to-profound sensorineural hearing loss were included in the study. NRT thresholds were obtained using AutoNRT algorithm intraoperatively and then in post-OP period – during the switch-on, 3 and 6 months after the CI activation. For thresholds assessment the electrodes E01, E06, E11, E16 and E22 were selected. During the follow-up after surgery NRT thresholds were registered on the same studied electrodes. **Results and discussion:** The average values of ECAP thresholds determined intraoperatively and during

measurements in the postoperative period were significantly different (p<0.001), while the average postoperative results were characterized by relative stability. The correlation increased in the first 3 months after the CI switch-on and remained high in the subsequent period. When comparing the results determined in 3 and 6 months after the implant activation, the correlation coefficient varied from r=0.76 to r=0.96, respectively. The registrations from the E01 differed significantly from all other registrations and were characterized by high average absolute differences and low correlation compared to the other electrodes. **Conclusions:** The data obtained in this study indicate that the NRT thresholds determined in the postoperative period significantly differed from the thresholds determined intraoperatively. There was no any specific electrodes or groups of electrodes stability detected during the studied time. Stable NRT thresholds results were determined from the period starting 1 month after surgery, during the activation of the speech processor of the cochlear implant. The obtained data allow us to conclude that NRT is a stable and accurate technique if used correctly.

Theory-of-mind development in prelingually deafened children (of hearing parents) with cochlear implants

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Objectives: Theory of mind (ToM) is the ability to mental states (beliefs, desires, emotions) to oneself and others. This ability emerges around the age of four years in typically developing children (TD) and it is crucial for the effective social interaction and communication. Accounting for the fact that ToM ability is acquired as a function of the language environment of the young child, children with delayed language development and limited language exposure may be at risk of delayed or impaired ToM advancement. One of the population which may be of interest in this respect are deaf children of hearing parents (DoH, deaf of hearing parents). In recent years, deaf children of hearing parents (DoH, deaf of hearing parents) are increasingly likely to receive CI at younger ages. Thus, this unique population with atypical language experience provide an opportunity to illuminate the relationship between early language deprivation, parents' mental state talk and theory of mind performance. The studies on prelingually DoH children who are treated with CI provide inconsistent results on ToM competences. Our study is also first which examines the relation between ToM development and parents' mental state language in children with CI. The present study aimed at exploring theory of mind development in prelingually deafened children who were cochlear implant users (CI). We also explored the relation between ToM performance, parents' mental state talk, language abilities and age at implantation. **Material and methods:** 30 children with CI (age 3.5–7.10; all implanted <24 months of age) and 30 typically developing children (age 3.3–5.11) completed computerized ToM task, which was designed based on standard unexpected transfer false-belief task. The caregivers completed Theory of Mind Inventory. Parents' mental state talk was analysed based on a book sharing interaction. The assessment of language skills was performed with Grammar- sentence comprehension from The Test of Language Development. **Results:** The results showed that after controlling for age and language ability, children with CI lag behind on false belief understanding, but not true belief understanding. Language ability was found to correlate positively with theory-of-mind performance. **Conclusions:** Deaf children (with CI) of hearing parents demonstrates delayed ToM development which most probably results from impoverished early conversational experience (prior to CI). Early CI is likely to provide complex language exposure and facilitate ToM development.

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Use of digital otoscopy to support tele-audiology

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Background: Digital otoscopy can be used to evaluate a range of clinical conditions, including otitis media and the status of tympanostomy tubes. Our center completed a pilot project integrating digital otoscopy into tele-audiology visits to improve access to hearing aid support services. Ten families were provided with inexpensive video otoscopes capable of generating images submitted to our electronic medical record system using a smartphone. **Methods:** Families were mailed the video otoscope along with the following instructions: 1. Plug in the device and charge it for 3–4 hours; 2. Download the appropriate app on their phone or tablet; 3. Connect the device and take/save pictures; and 4. Log into the hospital's medical record system (MyChart) and message the audiologist, attaching the appropriate pictures. Additionally, families were provided with instructional materials from the device manufacturer which explained how to download an app and to save an image. This documentation contained one picture of an intact ear canal but no additional instructions about how an ideal image should appear. The process of educating families in the use of the digital otoscope evolved over the course of the project: the process was modified with families receiving detailed instructions by mail or reviewed in person. In these instances, families were provided. **Results:** When using the initial, manufacturer generated instructions, only four of nine families were able to generate usable pictures. After modifying the handouts and instructions, an additional four families were able to submit usable pictures, including two children with chronic ear infections. Families were also asked to rate as Not At All True, Mostly True or Very True the following statements: 1. Downloading the App was easy to do; 2. The remote video otoscope was easy to use; 3. Transferring the information to MyChart was easy to do; 4. The information I received from the Audiologist was helpful; and 5. I would use the video otoscope again. 100% of families reported that it was "Mostly/Very True" that downloading the app, using the video otoscope, and transferring the images was easy. 100% of the families reported that it was Mostly/Very True that the information they received was helpful. 78% reported that it was "Very True" that they would use the video otoscope again. **Discussion:** For families who are motivated to master the use of video otoscopy as a tool for providing otoscopic images to their audiologist, inexpensive video otoscopy can be successfully added to a tele-audiology program.

Usefulness and problems of autonomic nerve measurement in chronic tinnitus

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Introduction: Tinnitus outpatients are undergoing tinnitus retraining therapy (TRT) using a hearing aid equipped with a sound source for patients with chronic tinnitus Although it was necessary to select the noise function, it was not evaluated as the most comfortable for the patient except for subjective symptoms, so we introduced an autonomic nerve measurement to select an acoustic therapy and experienced an effective case This time, we will report a case of autonomic nervous function evaluation. **Material and methods:** Subjects were first diagnosed with tinnitus outpatient clinic from July 2017 to April 2018, and 61 patients (31 men, 30 women, average age 61.0) choose the year of acoustic therapy Sometimes autonomic nerve measurements could be performed) Autonomic nerve measurement: The autonomic function of these patients was measured using autonomic function Analyzer (Fatigue Science Laboratory, Japan), measurement Both patient pulse and ECG are indicators Place your finger on the device Play heart rate variability At a specific frequency for each of the sympathetic and parasympathetic nerves Display nerve function and balance, Functional age of the autonomic nervous system referred to High frequency (HF) above 0.15 Hz reflects parasympathetic function, and low frequency/high frequency ratio (LF/HF) indicates autonomic function The measurement methods were (1) without hearing aid, (2) hearing aid + music, (3) hearing aid only, (4) music only. **Results:** Using 61 LF/HF values, the balance of all 61 autonomic nerves was examined as a balance group between 0.8 and 2.0, a parasympathetic innervation group of 0.8 or less, and a sympathetic innervation group of 2.0 or more The figure shows the distribution of autonomic balance in all 61 cases Autonomic nerves are divided into THI high value group (28 cases), THI intermediate group (13 cases), and THI low value group (20 cases) classified by THI And shows the percentage of balance In all cases, sympathetic dominant cases were observed in 48% of the sympathetic dominant group, 43% of the balance group, 10% of the parasympathetic dominant group, and approximately 50% Although the THI group was low, sympathetic dominant cases regardless of THI showed a frequency of about 50% In addition, in the study using acoustic therapy, the proportion of the sympathetic innervated group in all the 61 cases was (1) 48% of the control group, (2) hearing aid + music 45%, (3) Hearing aid 56% 4) Music has only changed to 55% The proportion of parasympathetic innervation groups varied from (1) 10% control group, (2) hearing aid + music 15%, (3) hearing aid only 11% (4) music only 6%. About 30 cases of sympathetic innervation group with LF/HF value of 2.0 or more (1) Control group (average 5.72) and (2) Hearing aid + music (average 5.04), (3) Hearing aid only (average 3.35) (P<0.05)), (1) Control group and (3) Hearing aid only (p<0.05), (1) Compared with control group and (2) Hearing aid + music groups (p<0.05), significantly reduced LF/HF values (P<0.01) was observed. **Conclusions:** Based on the analysis of individual cases, many types of sympathetic hyperparathyroidism and sympathetic nerve suppression feel comfortable, and those who felt uncomfortable observed reverse parasympathetic nerve suppression and increased sympathetic nerve activity In groups, the use of hearing aids, hearing aids + music showed a significant decrease in LF/HF values, the evaluation of autonomic function was the first visit of tinnitus outpatients, and could be a hearing aid with sound generator function Was suggested This test provides information to help select the function of the tinnitus.

Using remote technology for intraoperative monitoring during cochlear implantation

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Objectives: Intraoperative testing of cochlear implant device impedances and evoked compound action potential (ECAP) measurements are extremely important to assess the device integrity and response of the auditory nerve. Unfortunately, it is not widely performed due to the inconvenience of requiring an audiologist on site for testing. Surgical times are unpredictable and require the audiologist to be available for far longer periods of time than required for the actual device check. While tele-health and remote procedures are now commonly used for a variety of health-care based procedures, they have not been widely embraced for audiological service provision and generally not used for intraoperative monitoring of cochlear implant surgery. Little information is available from programs that are using this technology in order to allow other centers guidance in implementing this technology. We are documenting our recently implemented remote cochlear implant device operative monitoring of Med-El, Cochlear Americas and Advanced Bionic implants using a System Center Configuration Management (SCCM) System. **Material and methods:** 1. Initially we used a hospital specific desktop application (Center Configuration Management), transitioned to zoom but found it not to be reliable enough for monitoring and have since moved to another desktop application called MECM Remote Control. 2. We included the computers located in each of our operating rooms in our list of networked computers for each of the three manufacturer software programs used at our center. 3. We obtained programming hardware for each manufacturer that was dedicated to remain in the operating room area. 4. We trained our operating room staff on the appropriate hardware setup and placement for each of the three manufacturer devices used in our facility. 5. We generated a protocol that the Audiologist assigned to assist would be notified approximately 10 minutes before surgical support is needed so that they can log into the OR computer and be on standby to assist. 6. We perform real-time monitoring from a remote location. This can be done from any of our Primary Audiology site locations and into any of the secondary operating rooms. **Results:** Thus far, we have completed over 180 surgeries using remote intraoperative monitoring techniques. In each case, programming times have been significantly reduced: Surgical support times for bilateral surgeries have been reduced from 3 hours to 20 minutes per patient. Testing has been reliable for all cases. Also, in one of the cases, intraoperative monitoring revealed a faulty implant which required the insertion of the back-up device. **Conclusions:** Remote intraoperative monitoring is extremely important and easily implemented

using readily available commercial software such as MECM Remote Control. Use of this technology allows for our audiologists to see additional patients in the clinic resulting in more billable services while still being available to provide surgical support. As it is easily feasible and reliable, we believe that this should be a standard recommendation for all cochlear implant centers that do not have an audiologist on site to perform intraoperative device monitoring.

ePosters

A case of 11-year old patient with unilateral conductive hearing loss

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Introduction: Among school children who had some degree of hearing loss – conductive hearing loss is most common. A majority of hearing impaired children has chronic suppurative otitis media or other types of chronic otitis media, however there are also rare cases of children with congenital malformations of middle ear. **Objective:** To describe a case of 11-year old patient with unilateral conductive hearing loss due to congenital malformations of middle ear. Material and methods: 11-year old patient was admitted to Otorynolaryngology Clinic of World Hearing Center with hearing loss of left ear since early childhood. He hadn't any other complaints in subject examination. Physical examination with otoscopy had no ubnormal findings. The pure tone audiometry revealed modarate conductive hearing loss of left ear. CT scan of temporal bones was comissioned and radiologist described: narrow oval window, thicker than usually plate of stapes and subluxation/rotation of stapes cruses in left middle ear. The explorative tympanoplasty was planned and performed. During surgery functional ossiculoplasty and myringoplasty were executed. In case of no positive hearing result stapedotomy could be another step of traetment. **Results:** Preliminary results during first post-operative check-up revealed significant hearing improvement and air bone gap less than 20 dB. **Conclusions:** Diagnosis of congenital hearing loss in some patients could be relatively late and presented at school age, especially in unilateral cases. Ossiculoplasty for some group of patients with congenital middle ear malformations can achieve good hearing outcomes.

ABO blood group: Does it impact on auditory function?

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Objectives: Research suggests that individuals with different blood group antigens have different risk factors for many health disorders. For noise induced hearing loss (NIHL) several studies have found blood group O individuals exhibit a higher prevalence of NIHL compared to individuals with blood groups A, B, and AB. This may point to differences in auditory function among ABO blood types. A number of small scale studies have gone on to investigate the effects of blood group on otoacoustic emission recordings (OAEs), considering OAEs to be an index of cochlear function, and on functional hearing status. Group O males and females have been found to exhibit significantly fewer spontaneous OAEs and reduced transient-evoked (TEOAE) and distortion-product emission (DPOAE) amplitudes compared with A, B and AB blood groups, across a wide response range. Hearing threshold and speech discrimination outcomes have also been analysed for differences among blood groups. Speech discrimination ability in noise was noted to significantly reduced in listeners with blood group O. **Methods:** In the present study a larger cohort of participants across the four ABO blood groups is being examined [target n=400]. Examiners are blind to blood group status. An extensive test battery, comprised of a full range of OAE measures (TEOAE, DPOAE, spontaneous OAE and I/O functions) along with pure tone audiometry/ultra high frequency audiometry and tone in noise detection procedures are being used to determine auditory status. **Results:** Results to date for this large-scale, ongoing study will be presented and preliminary descriptive and inferential analyses provided for all hearing assessment procedures. **Conclusions:** Findings consistent with the hypothesis that individuals with different blood groups have different cochlear correlates would indicate the need for the further investigation of the effects of blood group on audition. Confirmation of such differences may lead to the need to consider haematological status as an NIHL risk factor and would also generate new insights into the basis of inner ear function.

Age-related hearing loss in the Korea National Health and Nutrition Examination Survey

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Objectives: Age-related hearing loss (ARHL), also known as presbycusis, is a chronic disorder characterized by impairment of the transduction of acoustic signals. This study analysed the prevalence and demographic characteristics of ARHL in the Korean population. **Methods:** We used the data from the Korea National Health and Nutrition Examination Survey (KNHANES) from 2009 to 2012 and analysed the association between age and hearing,,impairment. A total of 16,799 adults were selected for the current study. Physical examinations, blood tests, otoscopic examinations, and hearing tests were performed. The demographic variables included age, gender, obesity, economic status, education level, noise exposure history, and underlying diseases. **Results:** Among 16,799 participants, the prevalence of unilateral hearing loss was 8% (1,349 people), and bilateral hearing loss was 5.9% (989 people). Men were 53.4% more likely to have hearing loss than women. Age and underlying diseases, like hypertension, diabetes, and abdominal obesity, were significantly associated with hearing loss ($P<0.0001$). Further, mental health factors, such as cognitive function, depression, and suicidal ideation, were related to

hearing loss. The prevalence of hearing loss increased with advancing years, especially in the high frequency of 6 kHz, with a sharply increase in patients aged 65 and over. **Conclusions:** The analysis of auditory performance in the Korean population confirmed the association of high-frequency hearing loss with advancing age. A threshold of 6 kHz should be included to correctly diagnose hearing impairment in elderly patients. Patients with ARHL should be provided with suitable aural rehabilitation that includes active high-frequency control.

An innovative prototype device for electromagnetic ear stimulation in the treatment of subjective tinnitus

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Aim: The aim of the study is to evaluate the effectiveness of treatment of subjective tinnitus in patients with cochlear-sensory hearing loss using a prototype ear electromagnetostimulation device. Despite numerous studies and clinical trials on tinnitus, there is currently no 100% effective method of treating tinnitus. Various treatment methods are offered, including: pharmacotherapy, electrostimulation, hyperbaric oxygen therapy, laser therapy, noise masking with the use of Tinnitus Masker devices, hypnosis, etc. Among the methods of treatment, however, the most common method is habituation tinnitus (TRT), which has been used for 25 years. It seems that the most beneficial effects of tinnitus therapy are brought by combined causative and symptomatic treatment using several methods individually selected for each patient depending on the indications, and long-term monitoring of the effects of this treatment, supported by subjective and objective audiological studies. Another promising option for effective treatment of tinnitus is a prototype innovative device (patent of the Department of Otolaryngology, Laryngological Oncology, Audiology and Phoniatrics, Medical University of Lodz), which combines two methods (electrical and magnetic stimulation of the ear), which on the one hand creates additional treatment options in the absence of the effectiveness of one of the methods, while on the other it gives the opportunity to combine two types of physical stimulus, which is to increase the effectiveness of tinnitus treatment. **Material and methods:** The Research was conducted in 20 patients (24 ears) with tinnitus, aged 30–74 (mean 62.5 years), including 8 women and 12 men. Bilateral tinnitus occurred in 8 people and in 12 patients unilateral (left-sided in 7 and right-sided in 5 people), of which permanent in 16 ears and periodic in 6 ears. Typical audiology and imaging diagnostics were performer depending on the indications. Before the treatment, immediately after the end of treatment and after 3 months, tinnitus was assessed in the VAS scale (Visual Analyze Scale for loudness). In analogous periods, hearing in threshold audiometry was evaluated. The treatment cycle included 10 five-minutes timulations performed daily 5× a week. The stimulation coil (receiver) of the prototype device for electro-magnetostimulation was placed in the external auditory canal. **Results:** Immediately after the end of treatment the following results were obtained: in 18 ears (75%) improvement (reduction of tinnitus in the loudness range by 50–85%); in 2 ears (8.4%), the noise completely subsided; in 8 ears (33.3%) periodical tinnitus recurrence was obtained; in 4 ears (16.6%) the noise has not changed; none of the subjects was diagnosed with worsening of symptoms. The nature of tinnitus was as follows: before treatment-fixed in 20 ears and periodic in 4 ears; immediately after treatment-fixed in 10 ears, periodicin 12 ears and resolution of noise in 2 ears; 3 months after treatment-permanent in 8 ears, periodicin 14 ears and regression of noise in 2 ears. Based on the VAS scale for volume (loudnessscore): before treatment 4.9 points; after treatment 2.0 points and after 3 months 1.8 points. **Conclusions:** Preliminary results of the study indicate a high efficiency of magnetic stimulation in the treatment of tinnitus using a prototype device for electro-magnetostimulation of the ear. There was no negative effect of stimulation on hearing and tinnitus.

Analysis of research results of the original quality scale of music perception in cochlear implant usersers at the age of 4–6 y.o.

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Introduction: Music in human auditory development, a science and music program, assumes that music can be used as a therapeutic tool for children and adults with hearing disorders. **Aim:** the paper aims to present results of initial and control research allowing to assess the efficacy of the use of music therapy in hearing rehabilitation. The music rehabilitation was lasting a year and it was conducted in a group of 4–6 year old children. **Material and methods:** The study included a group of six children (4–6 y.o.). We used an original quality meter, elaborated in the World Hearing Center, to assess the quality of music perception and quality of music therapy process in cochlear implant users. The analysis was based on an examination of the group of patients before inclusion in the therapy. After the treatment, the group was examined again. **Results:** The process of hearing, speech, and language development were much quicker than typically. The children handled well it sound recognition, meaning technical hearing examination. The most difficult for this group was the differentiation of sounds within the interval sequence. Part of the analysis was not possible as the age of the participants did not allow to conduct the tests; we were not able to perform voice-vocal hearing examination. After a year of the music rehabilitation children, included in the music therapy program, performed much better with the responses and interpretation of the tasks involved in the quality meter than before the therapy. **Conclusions:** Our initial results indicate that the original music therapy program has a crucial impact on auditory functions, especially identification and hearing memory.

Analysis of the results of the original quality music perception scale used in cochlear implant users at the age of 7–12 years old

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Introduction: Music in human auditory development“ is an original music therapy program developed for patients with

hearing disorders. The program impends to extend care over children with hearing disorders from their first months of life. The program is designed to help cochlear implant users and patients with hearing disorders in quick and effective rehabilitation of hearing, which will allow them to naturally and permanently function in social, cultural, and professional life. **Aim:** The research aims to present the assessment results of the quality of music therapy conducted for a year in children at the age of 7–12 y.o. in the World Hearing Center. **Material and methods:** The material consisted of a group of 7 children between 7–12 y.o. An original measurement test, elaborated in the World Hearing Center, was applied to assess the quality of music therapy rehabilitation in cochlear implant users from the World Hearing Center in Poland. Patients were evaluated before and after inclusion in the music therapy class organized within the „Music in human auditory development" program. The authors used the following questionnaire titled The impact of music therapy on hearing, speech, cognition, emotional, and social development in patients with hearing disorders before and every three months during the treatment to monitor the efficiency of the music therapy sessions. **Results:** The process of development of auditory, speech, and language abilities was quicker than usual. After one year, the patients were able to deal with tasks and responses included in the quality meter. They better reacted to difficult tasks involved in the quality meter, such as differentiation of the musical phrases or number of detected sounds and differentiation within interval ratio. Besides the assessment using the quality meter, all children were assessed by their parents/carers in terms of hearing, speech, cognitive, emotional, and social aspects. The evaluation of skills was based on the responses in the above-mentioned questionnaire. **Conclusions:** Initial results show that original music therapy based on innovative program influences the development of auditory abilities, especially auditory identification and memory. Based on the observation of musical therapists and parents of the patients of the World Hearing Center, we can confirm that patients are taking part in music therapy willingly and with pleasure listen to music.

Assessing the effects of single-sided deafness on listening effort in adults

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In adults, SSD is known to cause impairments in social aspects but its impact in cognitive function is unclear. Here, we investigate whether artificially induced SSD results in an increase of listening effort via pupillometry. 20 healthy participants with normal hearing ability were subjected to induced single-sided deafness using earplugs and circumaural headphones. The cognitive function was determined by MOCA-k test, and working memory by reading span test. Eligible subjects underwent 4 sets of Sentence-final Word Identification and Recall tests in 3 different ear conditions (both normal, right SSD, left SSD). During the test, the pupil size was tracked; the baseline, peak pupil dilation, and latency were recorded. The pupil record was analyzed along with the SWIR score, a self-reported effort level and the reading span score. There was a significant increase in baseline pupil size when SSD was induced. PPD and latency were not affected by the induced deafness. Baseline pupil size increased more when SSD was induced on the dominant ear. An increase in baseline pupil size indicates that the cognitive effort for listening is more when a person has to rely on a single ear. When the hearing ability is compromised on the dominant side, the listening effort increases. The older group had larger PPDs than the younger group in all conditions. In order to achieve the same level of speech perception, the older group seems to require more listening effort. Compared to the high RS group, the low RS group had larger baseline when SSD was induced. It was the other way around without SSD. It means that without SSD, the high RS group has more working memory capacity to deal with the same task compared to the low RS group. When listening becomes challenging due to SSD, low group had less working memory capacity so that more cognitive resources are needed. Not much change occurred with the high RS group compared to the control since they were prepared to utilize more cognitive resources. This study has investigated into the cognitive effect of single-sided deafness in speech perception process, which affects at least a half of deaf population. It is important that this study suggests that SSD on the dominant ear may have worse outcomes on listening effort, drawing attention to the neglected importance of the relationship between the ear dominance and SSD. Moreover, this study has found that age and working memory which can be assessed by reading span test may have implications in regards to the relationship between SSD and working memory.

Assessment of the hearing status of school-age children from rural and urban areas of mid-eastern Poland

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Background: The purpose of this study was to assess the prevalence of hearing loss in,,school-age children from rural and urban areas of mid-eastern Poland using standard audiological tests – pure tone audiometry (PTA), impedance audiometry (IA), and otoacoustic emissions (OAEs). **Methods:** Data were collected from a group of 250 children aged 8 to 13, made up of 122 children from urban areas and 128 children from rural areas of mid-eastern Poland. Hearing was assessed in each of the subjects by means of PTA, IA (tympanometry), and transient-evoked OAEs (TEOAEs).,,Otoscopy was also performed. **Results:** There were significantly fewer abnormal results in children from urban than rural areas: they were, respectively, 10.1% and 23.1% for IA, 3% and 9.7% for PTA, and 17.3% and 31.8% for TEOAEs. For hearing-impaired ears in rural areas (failed TEOAE) hearing thresholds were, on average, 11.5 dB higher at 0.5 kHz than for children in urban areas. Comparison of each PTA result with the corresponding IA showed that all cases of hearing loss were

related to malfunction of the middle ear. **Conclusions:** The results of all three hearing tests were significantly worse in children from rural areas compared to those from urban areas. This indicates that audiological healthcare in rural areas needs improvement and that universal hearing screening programs for school-age children would be helpful.

Association between hearing loss and cognitive disorder: a nationwide population-based study

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Purpose: To investigate the relationship between hearing loss and cognitive disorder with memory dysfunction in South Korea using data from the Korean Health Insurance claims database for 2009–2015. **Material and methods:** We analyzed cross-sectional data of 66-year-old individuals who completed the Korea National Health and Nutrition Examination Surveys. Auditory function was evaluated using pure-tone audiometric testing. Cognitive disorder with memory dysfunction was assessed using standardized scores of the Prescreening Korean Dementia Screening Questionnaire. **Results:** Among 1,815,835 participants at the age of 66 years, the prevalence of unilateral hearing loss was 5.84%, and that of bilateral hearing loss was 3.40%. The normal cognitive group comprised 86.35% of the participants, and the high-risk group for cognitive disorder with memory dysfunction totaled 13.65% of the participants. The bilateral hearing loss group had the highest percentage of subjects who responded "sometimes or frequently" to all five questions about cognitive disorder with memory dysfunction, compared to the normal hearing group or the unilateral hearing loss group. After adjusting for sex, smoking status, alcohol intake, exercise, income, diabetes, hypertension, dyslipidemia, and depression, the odds ratios for cognitive disorder with memory dysfunction was 1.183 [95% confidence interval (CI): 1.163–1.203] for bilateral hearing loss and 1.141 (95% CI: 1.126–1.156) for unilateral hearing loss, compared to the normal cognitive group. **Conclusions:** Hearing loss has a significant effect on cognitive function in the Korean population. In our study, individuals with bilateral hearing loss showed poorer cognitive function than those with unilateral hearing loss.

AudBility: A novel method of an online program for central auditory processing screening in schoolchildren

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Objectives: Appropriate methods of hearing screening of auditory processing disorder (APD) in schoolchildren have been a challenge in audiology. This study aimed to present a novel method named 'audBility', an online program for central auditory processing screening in schoolchildren, considering the activity module directed to children from 6 to 8 years. The performance of students with typical development and absence of school and /or hearing complaints was compared with a group of children with learning difficulties. Design: cross sectional, quantitative and descriptive study approved by Research Ethics Committee of University of Campinas, Brazil, under number 2.294.609. **Material and methods:** A convenience sample of 154 students were evaluated. All children included presented normal results in the otoscopy and tympanometry test (MT10-Interacoustics). The screening program was applied in a silent room at school through a desktop computer and headphones, with an average time of 30 minutes. It was composed by a self-report questionnaire and playful activities that assess auditory tasks of Sound Localization (SL), Auditory Closure (AC), Binaural Integration (BI), Figure-background (FB), Temporal Resolution (TR), Temporal Ordering- Frequency (TO-F) and Temporal Ordering-Duration (TO-D). The mean score on questionnaire and each auditory task were calculated and presented based on a 95% confidence interval, considering sex, right ear (RE) and left ear (LE) and age as variables. Results were presented in percentage, only TR was measured in milliseconds. After data collection, a specific questionnaire was answered by the teachers of each class and analyzed individually, contained questions addressing student performance in the classroom and academic history: student participation, good school performance, attentiveness on activities, preference for a subject, behavior, interaction with other children/adults, evidence of respiratory and/or hearing disorders, difficulty with phonemes in speech, difficulty with recognizing phonemes in writing and understand the texts. Based on that, students were divided into two groups: Group I – GI was composed of 96 children with typical development (50 female and mean age of 7.47±0.97 years) and Group II – GII composed of 58 children with school difficulties (25 females, mean age of 7.69±0.84 years). **Results:** Groups were homogeneous in relation to sex (p=0.320) and age (p=0.226). In GI, variable sex showed influence only on BI task in RE, with better response for males; age influenced the performance on BI, AC, FB, TO-F and TO-D; with a statistically significant difference between 6 and 8 years and a better performance from 8 years; right ear presented a better performance on BI and TO-F. In GII, variable sex showed influence on BI in LE, TR and TO-F in both ears with a better performance on males; age influenced the performance on TR, BI, TO-F and TO-D, with better performance from 7 years and the right ear presented a better performance considering BI,TO-F and TO-D. It was shown a better performance of GI compared to GII in the following skills: BI task in both ears (GI: RE=90.9±8.6 LE=85.3±12.6; GII: RE=85.6±15.9 LE=79.1±14.2), FB in both ears (GI: RE=87.2±13.4 LE=86.3±13.7; GII: RE=80.1±20.2 LE=81.5±10.8),TO-F to the left ear (GI: 73.9±25.3; GII: 61.3±30.6), TO-D in both ears (GI: RE=34.5±28.8 LE=30.6±28.8; GII: RE=26.2±24.6 LE=19.6±22.3) and the performance in the self-report questionnaire (GI: 46.1±7.2; GII: 41.0±8.3). **Conclusions:** The program has proved viable for application with this age group and in a school environment. The performance was influenced by maturation. New studies are being conducted to validate these findings by means of diagnostic battery confirmation.

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Audiological and psychological profiles of children with tinnitus

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Introduction: There is limited knowledge of the incidence or severity of tinnitus in children. Population studies on the epidemiology of the condition among children give widely ranging figures making it difficult to ascertain the actual figure. As yet, there have been limited findings of a negative impact of tinnitus on children's day-to-day functioning. **Aim:** To gauge the audiological and psychological profiles of children with tinnitus. **Methods:** 25 paediatric patients who voluntarily came to our clinic in 2017 were included into the study. The children and their parents underwent a structured interview as part of a consultation in the Tinnitus Department. Otolaryngological examination and tonal and impedance audiometry were performed. Children filled a Visual Analog Scale (VAS) on loudness, annoyance, and how well they were coping with their tinnitus. Additionally, the Revised Children's Anxiety and Depression Scale and the Revised Children Anxiety and Depression Scale (Parent Version) was used, to look for possible depressive and anxiety disorders, and the EAS Temperament Survey to assess the temperament of the children. **Results:** Most of the children had normal hearing. Tinnitus had a significant daily impact on sleeping, studying, and leisure. The VAS scale results revealed that younger children, 6 to 10 years old, found tinnitus more troublesome than older children (11 to 16 years). No child with tinnitus showed any severe symptoms of depression or anxiety. All showed average levels of temperamental traits, close to normative values. **Conclusions:** When diagnosing tinnitus in children it is important to recognise that tinnitus affects children differently to adults. There is an urgent need to devise a questionnaire that can assess the impact of tinnitus on children's quality of life.

Auditory brainstem response test results in normal hearing adolescents with tinnitus

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Objectives: The pathogenesis of subjective tinnitus is not yet to be clearly established. It is often associated with hearing loss, but also appears in patients with normal hearing; affecting adolescents as well as elderlies. Meanwhile, auditory brainstem response (ABR) test objectively evaluates cochlea and brainstem auditory pathways. And several characteristics of ABR results in tinnitus patients with normal hearing have been suggested. This study aimed to evaluate ABR features of tinnitus patients with normal hearing thresholds in adolescent. **Methods:** The study population consisted of 8 adolescent patients with subjective tinnitus and normal hearing, who visited Otorhinolaryngology clinic in Korea University Ansan Hospital from Jan 2016 to Dec 2017. Patients were tested with pure tone audiometry, tinnitus test and auditory brainstem response test. For ABR, latency and amplitude of wave I, III and V, interpeak latency between wave I-III, III-V and I-V, and interaural latency difference. **Results:** Average of wave I amplitude among 8 affected ears was 0.30 (SD: 0.12) μV, and 0.45 (SD: 0.19) μV for wave V amplitude. Latency averages were 1.50 (SD: 0.27) ms for wave I, 3.67 (SD: 0.28) ms for wave III, and 5.49(SD: 0.36)ms for wave V. Although not statistically significant, latencies of wave I, III, V had tendency of prolongation in tinnitus ears of adolescents compared to non-tinnitus ears. Adolescents with chronic tinnitus (>6mo) tend to have more prolonged latency in wave I of tinnitus ear, compared to non-chronic tinnitus. Longer duration tinnitus may have pathogenesis in distal portion of auditory nerve in the region of ganglion cells. **Conclusions:** From the study, we sought to find ABR characteristics among normal hearing tinnitus children. Further evaluation and data collection could lead to further understanding of pathophysiology of tinnitus among adolescents.

Auditory function assessment in presbyiacusic elderly with and without mild cognitive impairment

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Introduction: Aging is a time-related natural phenomenon to living beings and marked by individual-specific biopsychosocial changes. From these changes, it is observed elderly people with hearing loss due to aging (presbycusis) and/or dementia processes that generate complications in communication, expression, capture and understanding of information. Cortical auditory evoked potential is an instrument used to assess the cognitive processes of hearing, providing information on the integrity of central auditory pathways correlated with language and communication. Age and mental integrity are factors that influence the responses of the auditory nervous system. The Montreal Cognitive Assessment Test, another instrument used to assess cognitive functions, assesses a wide range of functions (executive, visual and spatial skills, naming, memory retrieval, digits, sentence, abstract reasoning, and orientation) and contributes for the diagnosis of dementia and other mental disorders. **Objective:** To evaluate and compare auditory function in presbyiacusic elderly with and without mild cognitive impairment. **Methods:** This is an analytical and cross-sectional study. The study included 12 subjects aged ≥60 years, with symmetrical bilateral sensorineural hearing loss, with a high-pitched auditory threshold between 30 and 70 dBHL (considering 4, 6 and 8 kHz) and ≤25 dBHL at frequencies. 0.25, 0.50, 1 and 2 kHz, characterizing presbycusis, according to Corso (1977). The individuals were divided into two groups: Mild cognitive impairment group (GCCL): composed of 6 individuals of both genders who failed the MoCA test (score <26) (FREITAS et al., 2010); Control Group (CG): composed of 6 individuals, of both sexes, who did not fail the MoCA test (score >26) (FREITAS et al, 2010). The data collection procedure that comprised the auditory function test battery was the Cortical

Auditory Evoked Potential. For potential research, the stimuli were presented in intensity that guaranteed at least 30 dBNS, through earphones in acoustic speech stimulus /ba/ (frequent), /da/ (infrequent). The Montreal-Basic Cognitive Assessment (MoCA-B) test was applied after the PEAC examination in order not to interfere with the test results. For comparison of results, paired T test and Cohen's D test were used to analyze the effect of the sample. **Results:** After the t-test, it was possible to observe that, although the waves of the CCL group presented increased latency values compared to the CG, there was no statistically significant difference in the ACEP wave latency responses between the control and CCL groups: Lat P1. (p=0.68±22.98; effect size=0.17), Lat N1 (p=0.86±24.14; effect size=0.36), Lat P2 (p=0.84±33.9; effect size =11.9), Lat N2 (p=0.75±43.5; effect size=0.74) Lat P3 (p=0.59±34.23; effect size=0.22). The present study is ongoing, new results may arise from the increase in the number of patients. **Conclusions:** From the samples obtained so far, it was possible to observe that there was no difference in the auditory function of presbyiacusic elderly with and without mild cognitive impairment.

Auditory function in Charcon-Marie-Tooth disease: case report

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Charcot-Marie-Tooth (CMT) is a genetically neurological syndrome characterized by demyelinating peripheral neuropathy resulting in distal muscle weakness, sensory loss, arefexia, and slow motor and sensory nerve conduction velocities 1. Various conditions have been reported in association with CMT, including hearing dysfunction 2. The aim of this study was to investigate auditory pathway function of patient with Charcot-Marie-Tooth disease. A 42-year-old male, with a known history of Charcot-Marie-Tooth disease, that developed with hypotonia in the left lower limbs. He complains of hearing loss, walking difficulty and currently reports of dysphagia. Auditory evaluation comprised pure tone threshold (250Hz-8KHz) and electrophysiology tests: (i) auditory brainstem response (ABR); (ii) electrocochleography (ECoG); (iii) middle latency auditory evoked potential (MLAEP); and (iv) cognitive potential (P300). In pure tone thresholds we observed bilateral hearing loss in 6000 to 8000 Hz. Electrophysiological evaluation presented in click ABR presence of waves III and V with prolonged absolute latency values in both ears and interpeak interval (III–V) values within the normal range and in the right ear. ECoG test revelled absence of responses in both ears. For MLAEP we observed altered responses for ear effect (A1). Cognitive potential (P300) responses within normal limits in both ears. The alteration of auditory brainstem potentials (wave I) and absence of ECoG should be related with the involvement of cochlear nerve. The investigation of the central auditory pathway in patients with CMT is of great importance, since its audiological characteristics are diverse and can worsen with disease progression.

Auditory neuropathy spectrum disorder – 2 different but successful pediatric cases

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Introduction: Auditory Neuropathy Spectrum Disorder (ANSD) is a disorder characterized by disruption of the temporal coding of acoustic signals in auditory fibers with consequent impairment of auditory perceptions dependent on temporal cues. ANSD is a rare condition. It is associated with several risk factors and its diagnosis and management are challenging. **Objective:** To compare 2 pediatric cases of ANSD and analyze its rehabilitation. **Material and methods:** Analysis of behavioral and electrophysiological test results and medical genetic evaluation. **Results:** 1 child rehabilitated with cochlear implant and 1 child without any kind of adaption, but both with a good oral comprehension and a good speech development. Both children have risk factors for hearing loss, with present otoacoustic emissions but different brainstem auditory evoked potentials: the one with the cochlear implant has no response on brainstem auditory evoked potentials while the other one has a profoundly altered result on the exam. **Conclusions:** Auditory rehabilitation must be customized and guided by the functional performance of each individual child.

Auditory processing disorder and learning difficulties: School-aged children performance in behavioral and electrophysiological assessment

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Introduction: The large number of auditory complaints that are not justified by the evaluation of the peripheral auditory system led scholars to seek explanations through procedures that evaluated the central auditory pathway. Thus, these complaints are now attributed to central auditory processing disorders (APD). However, studies in the area show that other disorders, such as reading and writing difficulties, may often appear associated with APD. In addition, the diagnosis of APD has been the subject of recent major discussions due to the large participation of cognitive processes in the behavioral assessment test battery. **Objective:** The aim of this study was to investigate behavioral and electrophysiological responses in children with reading and writing learning problems. **Methods:** This Study carries approval from the Research Ethics Committee of UNICAMP (2.041.609). The participants were divided into two groups based on their performance on

reading and writing tasks. Children who had below average performances were included in a study group and the ones who had average or above average performance were included in the control group. Raven's Progressive Coloured Matrices method was applied to verify the intelligence level of all children. To be included in this study, all children have an average or above average (>percentil 26 or level III) intelligence level. This allows us to conclude that there is preservation of intellectual potential in all children. Participants totaled 54 children, with ages between 8 and 12, divided into two groups: a control group of 30 children and a study group of 24 children. All participants were submitted to evaluation of hearing with complete audiometry and high-frequency audiometry. Besides that, the following auditory processing tests were applied: Dichotic Digits (DD), Gaps in Noise (GIN), Synthetic Sentence Identification (SSI), Pitch Pattern Sequence (PPS), otoacoustic emissions, ABR, and P300 with tone burst stimuli. **Results:** No statistically significant differences were found in the evaluation of the peripheral auditory system. Behavioral results demonstrated that group comparisons showed differences for the DD, SSI GIN and PPS testes with control group performing better than the children with learning problems. No differences were observed for ABR responses. For P300 (tone burst) responses, the study group had significant longer latencies compared to the control group. **Conclusions:** Children with reading and writing problems performed poorly on standardized behavioral auditory processing tests and showed slower cognitive processing for tones.

Auditory steady-state responses in CI users

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Objectives: We have studied correlation between behavioral thresholds (pure tone audiometry in free field) and steady-state thresholds on acoustic stimulation in patients with cochlear implants. Younger patients who have received a cochlear implant (CI) system are generally unable to give sustained behavioral feedback, so there is a need objective method's for assessment of auditory nerve electrical stimulation levels. The most commonly used techniques for objectively assessing auditory nerve stimulation levels with a cochlear implant are Evoked Stapedius Reflex Threshold's (ESRT) and Evoked Compound Action Potentials threshold's (ECAP). A possible alternative to register sound perception thresholds on different speech frequencies (500 Hz to 4000 Hz) is the method of registering steady-state auditory potentials on acoustic stimuli in free field. **Material:** The present study included 53 subjects with Med-El CI system (Innsbruck, Austria) were examined in The Research Institute of Pediatrics and Children's Health of the Central Clinical Hospital of the Russian Academy of Sciences. The age of the study subjects ranged from 6 to 16 years old. **Methods:** The relationship between behavioral and electrophysiological thresholds was assessed by comparing the results of pure tone audiometry and ASSR thresholds. During the recording of steady-state auditory potentials via the speech processor. A separate part of the study included assessment of correlation between speech intelligibility and the mean values of ASSR thresholds in patients with developed speech skills. **Results:** As a result of comparing behavioral thresholds and ASSR responses on acoustic stimulation in a free field, the presence of correlation at all investigated frequencies was established. The correlation between behavioral and ASSR thresholds in patients with CI established as a result of this study. There is no statistically significant correlation between the decrease in ASSR thresholds and improvement in speech intelligibility was found. **Conclusions:** We have obtained data showing that the ASSR registration for acoustic stimuli in free field in cochlear implant users can be used as an alternative to pure tone audiometry in young patients. It can be informative in the initial period of hearing rehabilitation or with unobvious results. Further research is needed to assess the sensitivity of the method in uncorrected processor fittings, which can potentially be used as one of the indicators of the effectiveness of the rehabilitation process. The lack of a stable correlation between the dynamics of changes in sound thresholds and the results of speech audiometry does not allow the described method to be used for the evaluation of communicative skills.

Auditory stimulation in children with functional voice disorders

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Introduction: Vocal fold nodules in pediatric patients are a difficult clinical issue because of numerous etiological factors, differences in children anatomy, characteristics of behavior and emotional attitudes in the developmental age and low efficacy of therapeutic procedures in such cases. The above mentioned elements lead to recurrent episodes of this condition and have impact on effectiveness of treatment especially in school age children. **Aim:** The aim of the research was to analyze results of the novel auditory stimulation method in applied in therapy of vocal fold nodules in children. **Material and methods:** Material includes 198 children in the age 7–12 y. o. All Children were examined laryngologically and phoniatrically. The following auditory tests were performed: auditory attention test, pitch differentiation test and volume and sound length differentiation tests. The therapy aimed to stimulate three crucial spheres, which are important in the pathomechanism of pediatric dysphonia, meaning hearing, voice and emotions of the child. The biggest advantage of the therapy was the possibility to influence all the spheres in a child at one time, comprehensively. Auditory control in the process of voice production is an important element conditioning effectiveness of the continued rehabilitation of voice. Listening which is connected with psychological activity of people directly influences human voice. Modifying the listening processes we can influence voice and speech quality. Active listening process is therefore a skill which can be trained with specific sound stimuli. **Results:** After the therapy in 170 of children (83%) the vocal fold nodules remitted and voice improvement was observed. The result was confirmed by MDVP objective measures. **Conclusions:** Obtained results of the applied auditory stimulation of voice indicate that this method is clinically valuable. The elaborated program of auditory stimulation for children with dysphonias and voice nodules, considering abnormalities within development of

auditory and emotional functions is an effective method of therapy of voice in pediatric patients.

Auditory, visual, and auditory-visual working memory in individuals with cochlear implants

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Purpose: It is generally known for individuals with bilateral severe hearing loss that cochlear implants (CI) could help them to reach normal speech perception and production levels. However, individual differences in speech performance could be seen due to various factors. Neuro-cognitive factors such as working memory should be considered, especially in speech-language rehabilitation programs. Working memory is defined as the ability to store, process, and manipulate multiple information simultaneously for short periods of time. Many studies have shown that CI individuals exhibit working memory abilities that can be different from normal hearing individuals due to the limited auditory experiences, and could vary with the auditory or visual stimuli. The purpose of this study was to investigate the characteristics of working memory in CI individuals according to auditory and visual modalities using the digit span test in auditory and visual modalities and to examine the correlation between digit span tests and sentence recognition scores. **Methods:** Sixteen CI subjects with age matching sixteen normal-hearing subjects (aged 16~24 years) were tested with digit span tests. All digit span tests consisted of digits from 1 to 9, with each digit set being presented twice. The digit series were increasing consecutively from three to ten digits in each stimulus. The threshold of the digit span tests was determined as the exhibition of at least two incorrect responses of the previous digit series. Digit span tests (including forward digit span and backward digit span subtests) were each performed in the AO (auditory only), VO (visual only), and AV (auditory-visual) conditions. In the AO and VO conditions, subjects were asked to listen to the set of numbers that were presented at 1-second intervals through a speaker or a screen, respectively. In the AV conditions, the tests were conducted in both AV-Congruent and AV-Incongruent stimulation focusing only on the number of the auditory or visual stimulus. All participants were asked to respond verbally to both auditory and visual conditions. Additionally, the sentence recognition test was performed for only the CI subjects. Various ANOVAs and t-tests were conducted to compare the performance between test conditions. Furthermore, correlation co-efficiency was measured between digit span subtests and between digit span test and sentence recognition. **Results:** In the mono-condition (AO or VO), the normal hearing group showed significantly higher performance compared to the CI group in the digit span forward and backward subtests in both AO and VO conditions. All groups showed significantly higher performance in the digit span forward tests under AO and VO conditions compared to the backward tests. There was no significant difference between the AO and VO conditions in the normal hearing group as opposed to the CI group. In the multi-condition (AV), the normal hearing group showed significantly higher performance in the AV-Congruent condition than in the AV-Incongruent condition. In the CI group, the auditory modality was significantly higher in the AV-Congruent than in the AV-Incongruent, but there was no significant difference found in the visual modality. The Pearson correlation analysis showed that there were significant correlations between the digit span tests and sentence recognition. **Conclusions:** The results of this study revealed that the CI participants showed lower working memory abilities than normal hearing subjects in both auditory and visual digit span tests. When the auditory and visual stimuli were provided at the same time, the visual performance was more prominent. In addition, the results suggest that the working memory has an impact on the sentence recognition abilities in CI individuals. Therefore, working memory should be considered as an important factor in the speech-language rehabilitation programs.

Automation of hearing diagnostics in adolescents. Our experience

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Objectives: In the conditions of digitalization of healthcare, the robotization of some medical processes is becoming extremely popular, especially in situations where it is not possible to receive support promptly. This approach will help to effectively use the resources of the healthcare system. Automatic audiometry is an example of an automated diagnostic service, when algorithms and technical means are used to register sound perception thresholds. The author's presents their own experience of using the application of automatic audiometry. **Material:** The hearing thresholds were determined using the mobile hearing test application "Test-hearing-Audiologist, Ears, ENT", developed by IT For You CORP, version 2.1.5, installed on iPad, on iOS 11.0 platform, in Russian. The acoustic stimuli were supplied using Sennheiser HD 206 wired headsets (the frequency range is from 21 to 18,000 Hz; the max sound pressure level is 108 dB). A sample of 30 patient observations (n=30) was analyzed. The age of the subjects ranged from 7 to 17 years (Mean=12.27±3.27). Gender distribution in the study sample (n=30), girls accounted for 53.3% (n=16), boys 46.7% (n=14). **Methods:** To assess the accuracy of the automatic audiometry system, we compared the results of automated and clinical tests. The traditional method of pure tone audiometry was chosen as gold standard. **Results:** A comparison of the hearing thresholds obtained using pure tone audiometry with the results of automatic audiometry showed a discrepancy in the frequency range of 500 Hz, where the average difference was 11.8±3.07 dB HL. The smallest discrepancy in the results was obtained at a frequency of 4000 Hz – 8.0±3.9 dB HL. At frequencies of 1000 and 2000 Hz, there was a slight discrepancy – 10.2±4.3 and 10.17±4.2 dB HL, respectively, which was not statistically significant. **Conclusions:** The possibility of introducing screening tests to assess auditory function has a high potential for implementation into practice and will allow for the earliest possible detection of hearing loss in target groups of children, adolescents and students directly on the territory of educational institutions, without mandatory visits to a specialized clinic (medical organization).

Axonal sprouting and change in inhibitory transmission in the inferior colliculus after hearing loss

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Objectives: It has been suggested that hearing loss reduces inhibitory transmission in the central auditory system and leads to increased neuronal hyperactivity. This hyperexcitability may be due to reductions in inhibitory transmission in the inferior colliculus (IC). Thus, the present study evaluated changes in neural transmission after hearing loss as well as the effects of axonal sprouting on neural transmission in the IC. **Material:** Rats were divided into three groups: a control group that underwent a sham operation; a deaf group that underwent cochlear ablation on the left side; and a losartan group that underwent cochlear ablation on the left side and received losartan, which blocks axonal sprouting. **Methods:** The control and deaf groups were euthanized 1 or 2 weeks after surgery and the losartan group was euthanized 2 weeks after surgery. Then, the IC was harvested from the right side and the expression levels of axonal sprouting-related proteins and excitatory and inhibitory transmission-related proteins in the IC were measured with Western blot analyses. **Results:** Comparisons of protein levels at 2 weeks after surgery revealed that axonal sprouting-related proteins, including GAP-43, pSmad2, and pSmad3, were higher in the deaf group compared to the control and losartan groups. Additionally, inhibitory transmission-related proteins, including GABAAα1 and GAD-67, were lower in the deaf group than the control and losartan groups. There were no significant differences between the control and losartan groups. **Conclusions:** The present findings showed that, after hearing loss, axonal sprouting might occur in the IC and enhance reductions in inhibitory transmission.

Barriers to hearing aid adoption among older adults in mainland China

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Objective: From the diagnosis of hearing loss to hearing aid adoption, older adults with hearing loss all over the world often hesitate for many years. Several major barriers to hearing aid adoption have been reported such as self-perceived hearing, attitudes towards hearing aids, expectation towards hearing aids, information of hearing aids, and self-efficacy. Such findings may not be reflected in mainland China because differences in hearing healthcare infrastructure, health beliefs, and culture may also impact hearing aid adoption. The aim of the present study was thus to explore barriers to hearing aid adoption amongst older adults in mainland China. **Methods:** The study was conducted in a hospital, Beijing, Mainland China. Twelve participants over 55 years of age and who had not adopted hearing aids were recruited via ENTs (ear, nose and throat doctors) in the hospital and word of mouth. A semi-structured interview was used to allow older adults to express their perspectives freely and important information about barriers to hearing aid adoption. The interviews were audio-recorded and transcribed verbatim. Thematic analysis was used to code and analyze the data in Nvivo. **Results:** Three overarching themes and ten subthemes were generated to explain why older adults in mainland China do not adopt hearing aids: (1) Desire a cure for hearing loss, (2) Lack of perceived needs for hearing aids, and (3) Negative impressions and misconceptions of hearing aids. The first theme surrounds patients' experiences visiting multiple ENTs without being aware that the hearing loss was permanent. As a result, patients sought various alternative treatments such as acupressure and Chinese medicine that they later found unhelpful. The second theme indicated participants believed that they were still able to communicate by using strategies such as requesting their communication partner to speak louder or repeat while others stated it was not a big deal to have hearing loss. The third theme points to negative information or perception of hearing aids, leading to questionable effectiveness with hearing aid. They also reported that dissatisfactory attempts of hearing aid use and worries about hearing aid side effects had stopped them from going further. **Conclusions:** The results indicate that like their counterparts in Western societies, older adults who do not adopt hearing aids in mainland China do not readily perceive hearing needs and hold negative impressions and misconceptions of hearing aids. This study also uncovered some barriers that may be unique in the Chinese population, such as desire a cure for hearing loss. The under-developed hearing healthcare infrastructure, Chinese culture, Chinese health beliefs, and low health literacy play important roles in preventing older adults to adopt hearing aids in mainland China. The findings suggest that clinicians could ask the following questions when consulting older adults in mainland China to better understand their readiness to adopt hearing aids: (1) What do you understand about your hearing loss? (2) What treatments have you heard or tried for hearing loss? (3) How does your hearing loss affect you? (4) How do you feel about hearing aids? Asking these questions will help hearing professionals to understand and address barriers to hearing aid adoption.

Bilateral sudden mixed hearing loss: case study

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Background: This study presents a case of a patient with sudden hearing loss of a mixed type in both ears. **Case report:** A 45-year-old man came to our center for consultation because he had had no improvement in hearing after therapy in another clinic. In our clinic the patient was treated for 2 weeks. During each of his visits to our center, a battery of tests assessing the hearing organ were performed: pure-tone audiometry, impedance audiometry, and absorbance measurement.

Decisions concerning the treatments to be applied were agreed between both centers managing the patient. In consecutive visits improvement of hearing was observed. **Conclusions:** As test results showed, treatments with a wider spectrum of action, such as anti-inflammatory and immunosuppressant drugs, inhalations with an AMSA inhaler, and hyperbaric oxygen therapy restored the patient's hearing and eliminated the concurrent ailments he reported during the first visit.

Bilateral vestibulopathy: Aetiology and vestibular function

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Objective: To evaluate the extent of dysfunction of otolitic organ and in semicircular canals in patients with bilateral vestibulopathy (BV) in relation to etiology. **Material and methods:** This is a retrospective review of 211 patients (mean age, 63±15 years) with BV diagnosed in our dizziness unit between 2014 and 2021. All patients had undergone a standardized neurophthalmological and neurootological examination, cranial magnetic resonance imaging or computed tomography and laboratory tests. The vestibular function was established by the video head impulse test (vHIT), caloric irrigation and rotational testing with videonystagmography, cervical and ocular vestibular evoked myogenic potentials (VEMP). **Results:** Fifty five percent of the study population was male subjects. Previous vertigo attacks had occurred in 26%, indicating a sequential manifestation. The definite cause of BV was determined in 33% and the probable cause in 25%: The most common causes were idiopathic (45.7%), followed by ototoxic aminoglycosides (27%), meningitis and other infections (9%), Meniere's disease (4%), and head injury (3.5%), autoimmune (including Cogan's syndrome) (3.3%) and inner ear malformation (0.9%). Five percent of patients exhibited cerebellar signs and peripheral neuropathy meeting the CANVAS criteria and 3% only cereberllar ataxia. Severe damage of the entire vestibular organ was found in Canvas and in acute autoimmune inner ear disease (based on gain in rotatory chair, v HIT and VEMP) Idiopathic lesions, Meniere's disease and congenital malformations showed partial damage, differentiated, but usually the otolitic organ was less frequently and less damaged than the function of semicircular canals. Patients with Meniere's disease showed selective damage to semicircular horizontal channels. Individuals with idiopathic BV were more likely to have significant damage to the vertical semicircular canals (estimated using vHIT) than other etiologies. **Conclusions:** The cause of BV remains unclear in about half of all patients despite intensive examinations. A subgroups of patients with associated cerebellar dysfunction and peripheral neuropathy and as well as with and autoimmune etiology had more severe injuries.

Bimodal stimulation: A cost effective solution leading to improved speech and hearing outcomes for adults

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Introduction: Bilateral cochlear implants (CIs) are an effective treatment, however there are times where individuals will choose to supplement the CI with acoustic input on the contralateral ear. The combination of wearing a hearing aid (HA) in one ear with a CI on the opposite ear is referred to as bimodal listening 1. A recent systematic literature review from an International Delphi consensus paper 2 stated that individuals should use HAs with their CI to achieve bilateral benefits and the best possible speech recognition and quality of life outcomes. Evidence showed that implanted adults who used a HA in the opposite ear obtained significant benefits over CI-alone. The researchers recommend that bimodal fittings should be considered standard practice for CI-recipients.2 The objective of this poster is to outline the importance of binaural hearing, highlight the benefits and challenges that Audiologists may encounter and discuss treatment strategies to ensure successful outcomes. **Methods and results:** The importance of binaural hearing was uncovered and includes but are not limited to: (1) improvements in speech perception in quiet and noise (2) increased accuracy with localization and detection, (3) less loudness required due to summation effect, (4) both ears are active and less focus on auditory deprivation, (5) hearing sounds further in distance. The challenges encountered by audiologists when fitting bimodal patients include but are not limited to: (1) vast individual differences with speech recognition scores, (2) overall variability with speech recognition, (3) integrating two signals into one human auditory system, and (4) management of two separate hearing systems. A comprehensive treatment approach is imperative to achieving successful outcomes and should include several elements: (1) Clinical services should be conducted by an experienced Audiologist. (2) Collective effort of all parties should include the patient and significant others. (3) A patient specific profile should also be created, as well as (5) a comprehensive collection of outcome assessments which will assist clinicians to make data-driven decisions. 1,3 **Conclusions:** Evidence supports that bimodal hearing devices show improvement over the use of one single system alone. Bimodal listening improves speech recognition, sound localization, music appreciation and offers a more natural sound quality to the end user. With the advancement of technology, clinicians have tools for successful bimodal fittings. With support from industry, future work should emphasize preparing clinicians for the challenges that will arise during candidacy, fittings, management and how to successfully mitigate the issues to ensure successful outcomes for everyone.

Change of tinnitus perception after cochlear implantation according to Skarżyński Tinnitus Scale (STS) questionnaire

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Objectives: Tinnitus is defined as a sounds heard in one or both ears or in head, without any external acoustic factors. These noises can occur permanently or intermittently, causing a great deal of troubles in everyday human life. According to

literature, most of patients report lower tinnitus distress after cochlear implantation, compared to the preoperative period. Skarżyński Tinnitus Scale (STS) questionnaire, constructed of 15 questions, takes into account the impact of tinnitus on both the psychological (emotional, cognitive) and functional domains and the patient's ability to cope with tinnitus-related distress. **Aim:** The aim of the study was to check if there is a change of tinnitus perception after cochlear implantation according to Skarżyński Tinnitus Scale (STS) questionnaire. **Material:** The object of these study are patients undergoing their first cochlear implantation (none of the ears were previously operated) from February 2018. **Methods:** To assess the change in the occurrence of tinnitus, the Skarżyński Tinnitus Scale (STS) questionnaire was used. All of the patients were asked to fill in the questionnaire three times: preoperatively, one month after implantation and five months after implantation. As a whole, the STS has excellent reliability (ICC=0.94) and good internal consistency (α=0.91). The results of EFA and content analysis of wording of the items justified the three-factorial structure. The convergent validity was proven by a significant positive correlation with THI, TFI and THS Subscale A scores. **Results:** The analysis of the STS questionnaire results shows that in the preoperative period almost half (49%) of the respondents suffer from tinnitus, which has a significant impact on their quality of life. These patients obtained a high or very high result. After implantation (one month after activating the speech processor), the percentage of patients suffering from severe tinnitus (high or very high result) decreased to 29%, and within 5 months after the activation of the sound processor to 27%. Reduction of the demandingness of tinnitus in patients with hearing loss qualified for cochlear implantation had a significant impact on their quality of life and everyday functioning in society. **Conclusions:** Statistical analysis shows that STS is a brief but robust tool well-suited to clinical practice. A feature of STS is that it takes into account the impact of tinnitus on the patient's psychological (emotional, cognitive) and functional domains as well as their ability to cope with tinnitus-related distress. According to literature, the number of patients with tinnitus problem may increase in the future. Tinnitus is the cause of concentration disorders, increased tension and anxiety or depression and as a consequence, they can lead to withdrawal from professional and social life. Thereupon, it seems that the diagnosis and treatment of tinnitus might be a significant challenge for the health care system, especially in countries, were live expectancy increases.

Change of tympanogram after chronic otitis media surgery

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Objectives: Pre-operative eustachian tube function (ETF) is an important,,factor for the postoperative success after tympanoplasty, though much debates have been reported. In this study, we investigated the tympanogram changes after tympanoplasty, indirectly checking up ETF, to find out the relationship between tympanogram changes and associated factors after tympanoplasty. **Material:** Included in this study were 238 cases of tympanoplasty (canal wall up mastoidectomy with tympanoplasty type I or tympanoplasty type I only) performed by one surgeon for chronic otitis media from January, 2012 to June, 2017. In all cases, tympanometric tests were undertaken at one month, three month, six month, and one year post-operatively, and pure tone audiometry tests were taken at 1 year, post operatively. **Results:** The average hearing level and air-bone gap were 41.8±19.7 dB, and 17.1±9.3 dB, pre-operatively, and 29.9±21.1 dB, and 6.9±8.5 dB, 1 year post-operatively, respectively. Most of the cases showed improvement in hearing. The results of tympanometry showed that hearing improvement was greater for the A type than for the B or C type (p<0.001). The smaller the size of the tympanic membrane was, the higher the type A tympanogram appeared (p=0.008). **Conclusions:** The estimation of pre-operative ETF using post-operative tympanogram changes can give insight to the degree and process of recovery of the normal middle ear after tympanoplasty.

Changes of temporal processing and hearing in noise after use of hearing aids in patients with sensorineural hearing loss

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Background: The relationship between hearing aid use and the improvement of cognitive function is under investigation. The aim of this study was to evaluate whether hearing aids can recover the temporal resolution or hearing in noise function. **Methods:** We designed a prospective study of two groups; hearing aid users and control. Patients older than 45 years of age, with pure tone average threshold worse than 40 dB and speech discrimination score better than 60% in both ears were eligible. Central auditory processing tests and hearing in noise test (HINT) were evaluated in the beginning of this study and 1, 3, 6, and 12 months after the use of hearing aid in HA group and the control group. The changes of the evaluation parameters were statistically analyzed with the linear mixed model. **Results:** 26 participants (13 in the HA and 13 in the control group) were included in this study. Frequency test (p<0.01) and dichotic test (p=0.04) scores showed significant improvement in the control group after 1 year. HINT scores showed no change. **Conclusions:** After using HA for 1 year, patients performed better on the tests of temporal resolution. No improvement was documented regarding hearing in noise.

Children with tonsillar hypertrophy and otitis media

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Introduction: Adenoid and tonsillar hypertrophy are widespread among children. The typical management includes surgery (adenoidectomy and tonsillectomy) as well as different prescriptions for drug treatment. It is very common for children with adenoid and tonsillar hypertrophy to have different types of otitis as well, including its chronic forms. **Aim:** The aim of this study is to review medical literature and inspect the connection between adenoid/tonsillar hypertrophy and

different kinds of otitis in children, as well as to conclude the key points for new and better management of these diseases in childhood. **Material and methods:** A limited search with the keywords 'adenoid hypetrophy', 'tonsillar hypertrophy', 'otitis' and 'children' was conducted using the NCBITM and PubMed databases, which yielded over 20 articles, 10 of which were selected and thoroughly analyzed. **Results:** Multiple authors suggest that adenoid and tonsillar hypertrophy are important risk factors for recurrent otitis media with effusion. Recent studies show that there is less improvement in children with acute and chronic otitis media after adenoidectomy and adenotonsillectomy than expected. They propose different alternative treatments which are more cost effective and with less risk for the patients. **Conclusions:** Adenoid and tonsillar hypertrophy in children is one of the most common problems for general practitioners, pediatricians, and ENT specialists. By having one of these diseases the specialist should always inspect the possibility of having the other as well. The correct multidisciplinary management of both diseases is important for better quality of life in the small patients.

Chronic tinnitus and the positive effects of sound treatment via a smartphone app

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Background: Tinnitus is a phantom auditory sensation in the absence of an external stimulus. It is accompanied by a broad range of negative emotional symptoms and a significantly lower quality of life. So far, there is no cure for tinnitus although various treatment options have been tried. One of them is mobile technology employing dedicated applications based on sound therapy. The applications can be managed by the patient and tailored according to their needs. **Objective:** The study aimed to assess the effect on the severity of tinnitus from using a mobile application that generates background sounds. **Material and methods:** The study involved 68 adults who experienced chronic tinnitus. Participants were divided into a study group (44 patients) and a control group (24 patients). For 6 months those in the study group used a free mobile application that enriched the sound environment with a background sound. Participants were instructed to use the application for at least 30 min a day using their preferred sound. The participants in the control group did not use the application. Subjective changes in the day-to-day functioning of both groups were evaluated using the Tinnitus Handicap Inventory (THI) questionnaire, a visual analog scale, and a user survey. **Results:** After 3 months of using the application, the THI global score significantly decreased in the study group, decreasing again at 6 months. The largest improvements were observed in the emotional and catastrophic reactions subscales. A clinically significant change in THI was reported by 39% of the study group (17 of 44). Almost 90% of the study participants chose environmental sounds to listen to, the most popular being rain and ocean waves. In the control group, tinnitus severity did not change over 3 or 6 months. **Conclusions:** Although the participants still experienced limitations caused by tinnitus, the advantage of the app was that it led to lower negative emotions and thus reduced overall tinnitus severity. It is worth considering whether a mobile app might be incorporated into the management of tinnitus in a professional setting.

Cisplatin-induced cumulative ototoxicity based on pre-exposure hearing status

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Objective: Platinum-based chemotherapeutic drugs are considered the main treatment for various malignant tumors. The first generation platinum-based chemotherapeutic drug such as cisplatin is widely used among both adults and children often as a drug of choice. However, it is one of the most ototoxic drugs. The purpose of the study is to find out the cisplatin-induced cumulative ototoxicity based on pre-exposure hearing status. **Material and methods:** First time in Armenia, at Nairi MC, Armenia starting from October 2018, program for monitoring of ototoxicity is implemented for patients receiving chemotherapy. This is taking place in and being funded by Science Committee of Ministry of Education and Science of Armenia. The study included 20 adult patients who were exposed to Cisplatin 3–5 times; the range cumulative dose was 100-650mg. As a study sample each ear was examined individually. One of the patients one ear wasn't included in the study since the patient had initial unilateral hearing loss. As a result 39 ears were examined. The samples were divided into two groups. The first group included the ears (n=25) which hearing status didn't change after the treatment based on the results of the pure-tone audiometry (125–12 kH), while the second group included the ears (n=14) which hearing status altered by at least 15-dB based on the results of the pure-tone audiometry. 20 samples from the first group suffered from mild to moderate, moderate or moderate to profound hearing loss, the rest samples had normal pre-exposure hearing status. 10 samples from the second group had normal pre-exposure hearing status or mild haring loss, the other 4 samples suffered from mild to moderate hearing loss. **Results:** The ototoxicity of cumulative doses of 350 mg and lower was insignificant compared with pre-exposure hearing status. Hearing loss was found among 3 samples; 2 of them had normal pre-exposure hearing status, 1 of them suffered from pre-exposure hearing loss. The ototoxicity of cumulative doses starting from 400–550 mg was significantly associated with pre-exposure hearing status. Hearing loss was found among 7 samples; only 2 of them suffered from pre-exposure moderate hearing loss, the other 5 had normal pre-exposure hearing status or mild haring loss. 4 samples were exposed to cumulative doses of 600-650 mg. Hearing loss was found among all of them, but 3 of them had normal pre-exposure hearing status, 1 of them suffered from pre-exposure mild to moderate hearing loss. **Conclusions:** The prediction of the ototoxicity of cumulative doses of 350 mg and

lower is insignificantly associated with pre-exposure hearing status. Starting from 400 mg there was a considerable association with pre-exposure hearing status. Parallel to the dose increase, the ototoxicity on ears with normal pre-exposure hearing status is more predictable.

Clinical characteristic of patients with vestibular schwannoma and its relationship to tumor size

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Objectives: Vestibular schwannoma (VS) is the most common tumor in the area of the cerebellopontine angle. Depending on tumor size and localization, it may manifest itself in a variety of symptoms, the most common being tinnitus, hearing loss and balance disorders. **Material:** Retrospective case review of adult patients admitted to single tertiary clinical ENT center were carefully studied. The eligibility criteria were age ≥50 years, diagnosis of unilateral VS confirmed by a magnetic resonance imaging (MRI) and full medical record of a given patient upon diagnosis, including medical interview and hearing evaluation. Methods: Patients were divided into 3 groups according to Koos-Perneczky (KP) scale: first group with tumor size of 0.1–1 cm, second group – 1.1–1.9 cm and third group – 2.0–3.0 cm. Statistical analyses were conducted with IBM SPSS v. 24. **Results:** Based on the eligibility criteria, 19 patients were included in the final analysis (52.6% were men). Based on the KP scale, 63.2% of patients were classified to the first group, 31.6% to the second group and 5.3% to the third group. Tinnitus and hearing loss were observed in all patients (100%). Although all of the patients had unilateral VS, bilateral hearing loss was observed in 31.6% of patients and bilateral tinnitus in 15.8% of patients. Balance disorders were reported by 30% of patients and hyperacusis by 22.2%. None of the patients reported sudden hearing loss or facial nerve palsy. Interestingly, no statistically significant relationship were observed between the tumor size and existence of accompanying symptoms, as well as their severity. Additionally, low specify of the 3 kHz VS screening method according to Saliba, Martineau and Chagnon (2009) was observed, which found application only in 58.3% of patients from the first KP group, 0% of patients from the second KP group and in 100% (1 patient) from the third KP group. **Conclusions:** Patients with VS can report with a variety of symptoms of different severity, the most common being tinnitus and hearing loss. The current research failed to show the relationship between the presence and severity of clinical symptoms and the size of the tumor.

Cochlear implant processor fitting for individual cochlear anatomy

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Cochlear implantation uses data on the tonotopic organization of the cochlea in the distribution of signals through the channels of the electrode of the cochlear implant. The more accurate and natural the stimulation of the auditory nerve fibers, the better the perception of speech, sounds and speech intelligibility. Traditionally, when tuning processors, the principle of frequency distribution of electrodes is used, which is close to the tonotopic organization of the cochlea, taking into account the used coding strategy. These average values do not take into account the individual characteristics of the patient's cochlear anatomy. In the FSBI "SPb NII ENT" software was used to process the data of postoperative computed tomography in 3D to determine the geometric dimensions and anatomical features of the cochlea. According to the formulas obtained using the synchrotron, data were obtained on the individual frequency distribution of the studied cochlea, depending on the angular position of the electrode. Based on this data, the processor settings were corrected. Seven patients aged 8 to 36 years were examined using the Med-El cochlear implantation system, Concerto implant with various types of electrodes. Computed tomography of the temporal bones was performed in the standard mode on various devices with a slice thickness of 0.6 mm or less. After the anatomical adjustment, all patients noted a more natural sounding; in 3 patients, the peculiarities of the position of the electrodes were revealed, requiring additional adjustment of the adjustment. Deaf teachers noted an improvement in speech intelligibility. A new tool has appeared that allows you to significantly improve the quality and provide an individual approach to tuning processors after cochlear implantation. Thanks to the sound coding of the lowest frequencies, the electrode reaching the tonotopic location of the dendrites of the auditory nerve at low frequencies, the individual distribution of frequencies on each electrode, maximum speech intelligibility and natural sounding are achieved.

Cochlear implantation in adults with unilateral hearing loss: A review of recent studies

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Objectives: Recent findings regarding indications for cochlear implantation in adult and elderly patients with unilateral hearing loss are steadily increasing. They have been used to attempt to improve the binaural hearing abilities, such as the understanding of speech in noisy environments and sound localization. This article aims to write a review of recent studies to evaluate the clinical outcome of cochlear implantation in adult and elderly patients with unilateral hearing loss, namely, the effectiveness and benefit of cochlear implant use referring to binaural hearing abilities. **Material:** Studies on the topic of cochlear implant for adult and elderly patients

with unilateral hearing loss, in the form of articles written in Brazilian Portuguese and English and published in the past 5 years. **Methods:** A bibliographic review was carried out by means of the consultation of Lilacs, SiELO and Google academic databases using the following combinations of keywords: unilateral hearing loss and cochlear implant; cochlear Implant and hypoacusis. **Results:** 780 articles were retrieved altogether, 9 of which satisfied the eligibility criteria. After an integrated reading and analysis of the scientific studies, the majority of the clinical outcomes suggests important benefits of cochlear implantation in adult and elderly patients with unilateral hearing loss, especially the ability of sound localization, which was superior to the outcomes of using Bone-Anchored Hearing Systems. The remaining clinical data were more variable, possibly on account of large heterogeneity between studies. Some studies show the improvement of understanding of speech in quiet and noisy environments, and benefits regarding tinnitus. Some clinical outcomes were found which suggest that the cochlear implantation in adult and elderly patients with unilateral hearing loss is most sucessfuly in post-lingual adults. **Conclusions:** Even with the large heterogeneity between studies it is possible to conclude that the cochlear implantation in adult and elderly patients with unilateral hearing loss can provide sound localization ability in most cases, according to the studies mentioned. Larger studies are necessary to define the benefits of cochlear implantation in patients with unilateral hearing loss regarding to binaural hearing abilities, such as understanding of speech in noisy environments and benefits regaring tinnitus.

Cochlear implantation in congenital middle and inner ear malformations in children

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Introduction: Congenital structural inner ear malformations in syndromic patients are very rare and also difficult to manage. To list some of these syndromes: Treacher Collins, Goldenhar, Apert, Crouzon. Some syndromes, like branchio-oculo-facial are so extremely rare, that we could see only one or two such cases in our practice. **Aim:** The aim of the study was to show surgical technique used for cochlear implantation in patients with some of these rare syndromes and discuss the results obtained after surgical treatment. **Methods:** Patients with BOF, Goldenhar, EEC, and Goltz-Gorlin syndromes were qualified for CI treatment because of the bilateral sensorineural hearing loss and no effects with hearing aids. There were several problems during the operations: small mastoid, hypoplasia of the cochlea, congenital deformation of the ossicles, temporal bone hypoplasia and facial nerve displacement. We used Med-El implant systems in three patients and Nucleus system in one patient with Goldenhar syndrome. The technique of cochlear implantation was facial recess. Results: In all these cases we achieved satisfactory hearing levels although the results are worse than in children without structural deformities of the inner ear. Also, the results depend on malformation type and concomitant medical condition. No early or late surgical complications were observed. **Conclusions:** We point that even in cases with complicated anatomy and congenital malformations there is possibility to improve hearing using implantable devices. It is of crucial importance to focus on hearing improvement to maintain appropriate hearing levels and to give chance for those children to be active society members.

Comparative study of cognitive and hearing skills in functionally independent elderly

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Objective: To verify the existence of the relationship between P300 and cognition, to describe which cognitive skills are associated with the P300 result and to compare the hearing and cognitive findings between healthy elderly and elderly with high risk of frailty or frail ones. **Material and methods:** This is a cross-sectional, descriptive and comparative study conducted with elderly people divided into two groups: the study group (composed of frail elderly and those at risk of frailty) and the comparative group (healthy elderly). All of them underwent hearing and cognitive evaluation, and the procedures are described as follows: Tone Threshold Audiometry, Logoaudiometry, Evoked Potential (P300) Test, HHIE Questionnaire (Hearing Handicap Inventory for the Elderly), MMSE (Mini-Mental State Examination), CDT (Clock Drawing Test), and CERAD (Consortium to Establish a Registry for Alzheimer's Disease) battery. **Results:** There were 40 elderly in each group. The study group (frail elderly) was composed of 75% women and 25% men and the comparative group (healthy elderly) had 82.50% women and 17.50% men. The frail elderly had a higher perception of the handicap when compared to the healthy elderly (p=0.038). Hearing loss was present in 60% of healthy elderly and in 75% of elderly at risk of frailty/frail ones. There were more cases of altered P300 in the study group, and the language, executive function and memory skills and the MMSE result were associated with the P300. **Conclusions:** Hearing loss has a high prevalence in both groups, but the perception of the handicap is higher in frail elderly, as well as the change in the P300. The P300 is associated with language and executive function skills in healthy elderly, and the executive function, MMSE and memory are associated with the P300 in frail elderly. The comparison between frail elderly and healthy ones enriches the discussion about the impact of frailty on hearing and cognitive skills, differentiate the elderly population from the health professionals' perspective and favor improvements in the elderly care.

Comparison of ECAP thresholds in CI patients with different ASSR levels

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Objectives: The study proposes to investigate the correlation between preoperative auditory steady-state response thresholds (ASSR) and intraoperative electrically evoked compound

action potential (ECAP) thresholds. **Material:** A total 40 patients with sensoneural hearing loss were examined using the ASSR test before cochlear implantation (CI). They were divided into 3 groups depending on the number of ASSR thresholds. Group 1: 1 threshold. Group 2: 2 thresholds. Group 3: 3 and 4 ASSR thresholds. **Methods:** Intraoperative ECAP registration was performed for all patients via autoART protocol (Med-El). The number of channels with recorded responses was estimated. **Results:** 61% of the channels of CI systems had ECAP threshold in group 1. 71% of the channels had ECAP threshold in group 2. 78% of the channels had ECAP threshold in group 3. **Conclusions:** ASSR test can be used to assess the condition of the cochlear nerve before CI. ASSR results can be used for choosing the ear for implantation.

Comparison of the frequency of positive hearing screening results in school-age children from different countries around the world

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Objectives: According to the guidelines of the European Scientific Consensus on Hearing (European Federation of Audiology Societies 'EFAS' Congress, June 2011, Warsaw, Poland), the detection and treatment of communication disorders in early school-age children is the highest importance. This objective was adopted by the Polish president of the EFAS Council from the second half of 2011; as a result, pilot programs on children's hearing screening were initiated in various countries in Europe, Africa and Asia. The aim was to compare the frequency of positive outcomes of hearing screening between the countries. Examinations allow for an early detection of hearing disorders, thus enabling treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. Hearing-impaired children often experience delayed development of speech, language and cognitive skills, which may result in slow learning and difficulty progressing in school. These efforts are aimed at improving the state of medicine abroad, especially in African and Asian countries, enabling access to health care and promoting healthy lifestyle. **Material:** Hearing screening was performed in group of almost 5.000 children aged from 6 to 12 years. Hearing tests were performed in African, Asian and European countries. **Methods:** Screening was performed using the Sensory Organs Platform; based on an audiometric hearing threshold measurement procedure. A modern platform developed by the Institute of Sensory Organs is essential for the affordable and universal study of a large population of children. The threshold values for air conduction were determined in the frequency range of 0.5–8 kHz. The abnormal test result was the threshold value for air conduction of 25 dB HL and more for at least one frequency in at least one ear. In addition, in some countries, the study protocol was extended to include video-otoscopy. **Results:** A positive result of hearing screening was found in 15.9% to 24.1% of the children tested. Most of the hearing loss was benign or moderate, most often among all ears with abnormal hearing screening in children with high frequency hearing loss. In addition, there was a large number of unilateral hearing loss. Studies have shown that the scale of hearing loss among school-age children is significant in all countries participating in the program. **Conclusions:** This study demonstrates that there are many children in primary schools who have hearing problems, and this situation may affect their education. The solution could be screening programs conducted directly in schools by trained school personnel (e.g. school nurses). The program of hearing screening in schoolchildren described here has helped to raise awareness of the importance of hearing conservation and inspired the development of new programs.

Complications after cochlear implantation – analysis of the Department of Laryngology, Medical University of Silesia

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Introduction and purpose: Cochlear implantation is a commonly used method of treating total and partial deafness in both children and adults. It has been performed at the Laryngology Department and Clinic of SUM Katowice since 2004. The aim of the study is to analyze the most common early and late complications. **Material and methods:** The study analyzed the course of treatment of all patients who underwent cochlear implantation in the years 2004-2020 at the Department of Laryngology, Medical University of Silesia in Katowice. In total, the study included 182 patients (87 men and 95 women) with a mean age of 48±20 years. In all patients, the procedure concerned primary implantation and was performed unilaterally. **Results:** In the study group, 90.1% were adults and 9.9% children. The mean hospitalization time was 6.1±2.1 days, and in the case of patients with complications, it was 6.87±2.93 (p=NS). The most common type of hearing loss was postlingual hearing loss, it affected 137 patients. The cause of the hearing loss was unknown in 53.2% of the cases. Among the remaining patients, the most common cause of hearing loss was the use of ototoxic drugs and exposure to noise. Complications occurred in a total of 19 patients (10.4%). The most common complication was dizziness – 8 patients (4.3%) – 5 of which concerned only the perioperative period. In 4 patients (2.2%) facial paralysis was diagnosed – in 2 patients it resolved spontaneously. Removal of the cochlear implant was necessary in two patients due to persistent severe dizziness and headaches. **Conclusions:** Cochlear implant surgery is a safe procedure with a low risk of complications. The main complication in the study group was dizziness, which in most cases was transient and self-limiting.

Concert of active music – application of original music therapy exercises

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Introduction: The music rehabilitation team of the World Hearing Center realizes music therapy rehabilitation according to the designed original therapeutic exercises program

that includes musical compositions titled Music in human auditory development. The program consists of sets of active and passive exercises and music forms, questionnaires, and tests assessing the cochlear implant user's level of development, applying an original music therapy quality meter, performed every three months during the one-year rehabilitation period. **Aim:** the research aims to present the active and passive exercise sets used in separate age groups. **Material and methods:** Material includes 17 pediatric cochlear implant users in the following ages: 0–2, 2–4, 4–6, 7–12 years old. Original therapy was applied in the implanted patients during music therapy sessions. The method was elaborated by the music therapy team of the World Hearing Center. The most crucial tasks of the hearing education in children consist of several developmental phases: the creation of concepts, reaction to presence and absence of a sound, identification (remembering and recognition of sounds), sound localization. The sets include presentations of music therapy sessions for every age group. The presented scheme was based on four seasons of the year. In every age group, we gave one basic course in one season of the year and one modified session. Each exercise includes one of the dedicated musical therapeutic aims. **Results and conclusions:** The initial results are promising and indicate the need to include music therapy in hearing rehabilitation of every implanted child. Active exercises in the program also called Active music concerts dedicated to the implanted patients and performed during the music therapy sessions, accelerate auditory development, and contributing to the general development of pediatric patients.

Conductive hearing loss and ear-related pathologies in an unselected sample of 85-year-olds

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Objectives: The number and proportion of older persons is expected to increase in the future. The vast majority of 85-year olds have symmetrical sensorineural age-related hearing loss (ARHL). However, some have an additional conductive component, i.e. mixed HL, leading to a worse degree of HL, which is associated with increased handicap scores. A calculation of the prevalence of conductive/mixed HL and middle ear diseases; chronic otitis media (COM) and otosclerosis, in older age can lead to a future projection of the need of rehabilitation. **Material:** Audiological data of an unscreened sample of 85-year-olds (n=125, 50% men) were studied and the prevalence of conductive/mixed HL, as well as for different middle-ear diseases (COM and otosclerosis), were analyzed and compared with prevalence figures from an earlier studied birth cohort of 85-year-olds, born in 1901–1902 (n=249, 38% men). **Methods:** The study was part of the Gothenburg H70 Birth Cohort Study. Clinical pure-tone audiometry was used and both air (0.25–8 kHz) and bone-conducted (0.5–4 kHz) thresholds were measured in the two birth cohorts. Audiometry, tympanometry, and self-reported data were used in the analysis of different middle ear diseases. **Preliminary results:** Conductive/mixed hearing loss was diagnosed in 6.5% of 85-year olds, born in 1930, and in 6.7% of 85-year-olds, born in 1901–1902. COM were documented in 1.2% of the ears in the earlier-born cohort as well as in the later-born cohort. Otosclerosis was documented in 2.4% of the ears in the earlier-born cohort and in 1.2% in the later-born cohort. Further, not-defined conductive/mixed HL was documented in 3.2% of the ears in both the birth-cohorts. **Conclusions:** The proportion of 85-year-olds with a conductive/mixed HL has not been changed over 30 years. The prevalence rate of COM, otosclerosis and not-defined middle ear diseases was also virtually unchanged. However, in the later born cohort, only 27% of the ears, with self-reported COM in combination with a history of ear surgery, had a conductive/mixed HL. The proportion of middle ear diseases, followed by a conductive HL, will possibly decrease in future due to better preventive actions, medical care and treatments.

Costen syndrome in children

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With regard to the development of Costen syndrome the main importance is attached to the pathological processes developing in the temporomandibular joint (TMJ). In the majority of cases the problem occurs when the ligamentous apparatus of the joint is weakened due to improper dental occlusion, which could be a consequence of caries, partial or total loss of teeth, increased erasability or mobility, especially often with diphyodontics or injuries, as well as a result of changes in the bite or improper sanitation. Weakening of the ligamentous apparatus changes the load on the joint. According to Costen, the movements of the altered articular head may affect the auditory tube, affect the mobility of the eardrum and increase the pressure on the ear-temporal nerve. Costen syndrome is often called a chameleon disease or a "double" of otitis media. According to WHO, about 40% of the population aged 20 to 50 years suffer from TMJ dysfunction, which is 78% of those who have visited a dentist. The most important from the anatomical aspect and biomechanics of joint movements is the posterior attachment of the intra-articular disk, the posterior surface of which adheres to the posterior wall of the mandibular fossa of the temporal bone and the head of the lower jaw. One part of the ligament connecting the malleus of the middle ear with the capsule and disc of the joint (described by Pinto in 1962) is directed from the malleus to the auditory tube, and the other two connect the anterior process of the malleus with the capsule of the joint and the awl-mandibular ligament. This circumstance can be considered as a link between the ear diseases and TMJ. In the available literature the question of myofascial pain and temporomandibular dysfunction, TMJ diseases, which are somehow associated with adult ear diseases, is quite widely covered. However, there is a lack in publications in relation to children. The purpose of the study was to investigate: is the Costen syndrome in children correlation or coincidence?

Over the past three years on an outpatient ENT appointment we examined 143 patients aged from 6 to 14 years who complained of sudden sharp ear pain, congestion in the ears or hearing loss, including recurring episodes; some of them noted tinnitus, discomfort in the ears. All children were examined by an ENT on the day of treatment, the tympanometry and the otoacoustic emission registration were performed. The cohort of patients with isolated otalgia (14.1%) was examined by a neurologist to exclude facial neuropathy. In 58.6% of cases, the secretory otitis and/or dysfunction of the auditory tubes was confirmed. The dentist examined 137 of 143 children and in 96.4% confirmed the dental diagnosis: anomalies of the position of the teeth – in 16% of cases, anomalies of the ratio of dental arches – in 54%, malocclusion – in 10% and malformation of the jaw – in 20% of cases. The majority of patients had orthopedic disorders (*N*=82; 87.1%). The data obtained indicate the relationship of ENT diseases and impaired dental occlusion, which suggests that Costen syndrome or temporomandibular dysfunction in children is not a coincidence, but is a correlation. This, in turn, is a guide to an interdisciplinary approach in the management of patients with this pathology.

Cystic fibrosis: Behavioral, electroacoustic and electrophysiological auditory evaluation in children and adolescents

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Objectives: Cystic Fibrosis is an autosomal recessive disease that effects the exocrine glands. These glands, when producing viscous secretions, cause manifestations, mainly respiratory and digestive. One of the studied effects related to the treatment of the disease is the use of aminoglycoside antibiotics and its action in the cells of the organ of the hearing, the cochlea. Aminoglycosides are known to be at risk for the development of sensorioneural hearing loss. The presence of adequate sound stimulation is essential for the maturation of auditory abilities. It is fundamental that the peripheral auditory system is intact, especially in childhood. If there is a reduction in environmental sound stimulation, there may be changes in the patterns of organization of hearing and learning abilities, contributing to language difficulties and changes in Central Auditory Processing. Based on the literature on the disease, no studies were found to evaluate an auditory extension of these patients, from peripheral to central structures, as well as their function and importance in hearing skills. The objective of this study was to analyze peripheral and central hearing of children and adolescents with cystic fibrosis. **Methods:** A total of 117 from 7 to 21 years old patients were evaluated, 57 of them with cystic fibrosis and 60 of the control group, using pure tone audiometry, high frequency audiometry, transient and product distortion otoacoustic emissions, behavioral evaluation of central auditory processing, brainstem evoked auditory potential and long-latency auditory evoked potential. **Results:** Children and adolescents with cystic fibrosis presented higher auditory thresholds than the control group in the frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000, 8000, 9000, 10,000, 11,200, 12,500, 14,000 and 16,000 Hz, in addition to presenting reduced amplitudes of transient otoacoustic emissions and product distortion in relation to the control group. Children and adolescents with cystic fibrosis who received aminoglycosides intravenously had higher auditory thresholds in most of the assessed hearing frequencies and reduced amplitudes of product distortion otoacoustic emissions than those who did not use aminoglycosides intravenously. Children and adolescents with cystic fibrosis presented worse performance in the gaps-in-noise test compared to the control group in the evaluation of central auditory processing, which indicates impairment of temporal resolution auditory ability. There was no significant difference in the dichotic digit test, frequency pattern test and synthetic sentence identification test with competitive messages compared to the control group. They also showed increased latency in I and V waves of brainstem auditory evoked potential, as well as an increase in P300 latency in long-latency auditory evoked potential. **Conclusions:** Children and adolescents with cystic fibrosis presented normal results in the peripheral evaluation of hearing, but with a significant difference in relation to the control group. They presented indicative of impairment in the temporal auditory ability in the Central Auditory Processing and significant differences in the electrophysiological latencies in relation to the control group. Children and adolescents who used aminoglycosides intravenously had significantly worse outcomes in the evaluation of peripheral hearing than those who did not use these medications.

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Deafness in Mohr-Tranebjaerg syndrome with X-linked agammaglobulinemia

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Objectives: Mohr-Tranebjaerg syndrome, known also as deafness-dystonia-optic neuronopathy (DDON) syndrome is characterized by progressive auditory neuropathy, dystonias that appear in adolescence, progressive optic atrophy which occurs in the end of second decade, and dementia, beginning after fourth decade of life. The gene responsible for DDON syndrome is located in Xq22, adjacent to the gene related to X-linked agammaglobulinemia. The aim of the study was to characterize challenges in DDON syndrome patient communication disfunction diagnosis. **Material:** An almost 6 years old boy with X-linked agammaglobulinemia and DDON syndrome was hospitalized in order to diagnose hearing and speech disorders. The patient passed his newborn hearing screen by transiently-evoked otoacoustic emission (TEOAE) testing. TEOAE tests have been repeated several times after the DDON syndrome was diagnosed – with correct results. Nevertheless the patient has not developed speech. **Methods:** The patient has undergone otolaryngological, audiologic, foniatric, logopedic and neurological examinations followed by an IQ assessment. Audiologic workup scope included auditory brainstem response (ABR), transiently-evoked otoacoustic

emission (TEOAE) testing, tympanometry and stapedius muscle reflex. **Results:** The examination results were deep hearing loss with auditory neuropathy features in both ears accompanied with receptive and expressive language delay. A hearing aid was administered for both ears. **Conclusions:** Pre- or post lingual auditory disfunction is part of Mohr-Tranebjaerg syndrome. The analyzed case shows the necessity of full audiologic workup, especially if speech disorders are observed.

Development of auditory skills between 5 and 7 years old

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Objectives: The aim of this study was to evaluate the development of auditory skills between 5 and 7 years old. **Material and methods:** This longitudinal study was approved by the institutional ethics committee. Thirty-five children who had their auditory skills evaluated at two different times (evaluation 1 and evaluation 2) were included. The Inclusion criteria were: children aged 5 years and 6 years and 1 month; hearing thresholds ≤15 dB HL at 0.5, 1 and 2 kHz and ≤20 dB HL at 0.25, 4 and 8 kHz. The following were excluded: children who complained or were diagnosed with neurological or psychiatric disorders; children who did not attend evaluation 2. At evaluation 1, the children were between 5 years 2 months and 6 years 1 month of age, and at evaluation 2, they were between 7 years 1 month and 7 years 8 months of age. The interval between the evaluations ranged from 18 to 23 months. Based on the results of evaluation 2 (at 7 years), the children were classified and divided into 3 groups: GI included 9 children with at least two auditory processing tests that scored below the standard and the presence of a speech complaint; GII included 18 children with at least two auditory processing tests that scored below the standard and no speech complaints; and GIII included 8 children with no more than one test scored below the standard and no speech disorders complaint. Procedures: The auditory tests applied in both evaluations (1 and 2) were: pure-tone audiometry, speech tests (SRTacoustic immittance measurements, otoacoustic emissions, Pediatric Speech intelligibility test ipsilateral with signal/noise ratio=0 (PSI (0)) and –10 (PSI (–10)), Dichotic Digits test (DDT), Pediatric speech intelligibility word with ipsilateral white-noise (PSI-WN)), Memory sequence verbal test (MSV), Memory sequence non-verbal test (MSNV), sound localization and Random Gap Detection Threshold (RGDT). The analysis were performed considering each test individually or as a battery of applied tests. From the results obtained, a discriminant analysis was performed to assess the differences in test performance between the groups when the children were 5 years old. **Results:** There was a significant difference between the groups in the performance of the following tests in evaluation 1: MSNV, PSI (0), PSI (–10), PSI-WN and DD. For the mathematical function of discriminant analysis, only those that showed significant difference between the groups were considered. Discriminant analysis showed that with the results obtained during the evaluation 1, 74.3% of the children remained classified in the same group after the evaluation 2.The percentage of correct classifications for each group was 77.8% for GI, 66.7% for GII. 87.5% of the children who were classified as GIII after evaluation 2 had already demonstrated good auditory performance in the tests at 5 years of age. **Conclusions:** Although children showed evolution in hearing performance between 5 and 7 years, those who exhibited lower scores on auditory processing tests at 7 years of age had also demonstrated poor performance on auditory processing tests at 5 years of age. This finding is relevant because stimulating these auditory skills in preschoolers might promote their development, mainly in children with speech complaints, since these children are more likely to maintain the low performance that they presented at five years of age through seven years of age.

Distortion product otoacoustic emissions: Values of amplitude

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Objective: Individuals with hearing within the normal range and presence of Distortion Product Otoacoustic Emissions (DPOAE), have a varied amplitude in the range of emissions when compared to each other or between the frequencies tested. Therefore, it is important to determine if DPOAE amplitudes are normal or abnormal. In some cases, a quick analysis leads to the confident conclusion that the findings are normal when noise floors are consistently low across the frequency region and the DPOAE amplitudes are reliably within a normative range defined by the 5th to 95th percentile lines. In other cases, the analysis will require a thorough examination of each of these response parameters, and their correlation with other audiologic findings. However, there is no literature on normative data on the expected DPOAE amplitude values performed using the ILO version 6, Otodynamics®, equipment and these data can be premeditated for further investigation in cases with present but reduced amplitude DPOAE response. Thus, the aim of the study was to analyze the DPOAE values in children with typical development and normal hearing. **Methods:** A total of 114 ears (57 individuals) between the ages of 7 and 15 years were evaluated, 29 female and 28 male. We used as inclusion criteria to constitute the study group, individuals without otologic symptoms, history of middle ear infection, ear surgery and with audiometry assessment within the normal range according to the criteria of the World Health Organization. Then, the individuals were submitted to research of DPOAE. In the DPOAE, the frequencies f1 and f2 were presented simultaneously, in the intensities of 65 dB and 55 dB, respectively, in the relation f2/f1=1.22. The frequencies f2 investigated were 1; 1.4; 2; 2.8; 4 and 6 kHz To the realization these procedures, an otoacoustic emission analyzer model ILO version 6, Otodynamics®, was used. DPOAE were found to be present when the difference between amplitude and noise was greater than or equal to 3 dB, at frequencies of 1 and 1.4 kHz and when the difference between amplitude and noise was greater than or equal to 6 dB at frequencies of 2; 2.8; 4 and 6 kHz. Then, the collected data were tabulated and subjected to statistical analysis using the MINITAB 16 software. Descriptive analysis comprised measures of central tendency (mean and median), dispersion (standard deviation) and position (maximum and minimum). **Results:** When performing DPOAE in the

114 ears, all presented presence of response. The results obtained from the descriptive statistical analysis of the amplitude of the emissions for each frequency presented lower average for the frequency of 1000 Hz, being 21,068 with a confidence limit of 19,997 for 5th percentile and 22,139 for 95th percentile. The 1400 Hz and 2000 Hz frequencies presented similar position measurements, with an average of 1400 Hz equal to 24,705, with a confidence limit of 23,774 to 5th percentile and 25,636 to 95th percentile, while for the 2000 Hz frequency the average obtained was 24,751, with confidence limit from 23,918 to 5th percentile and 25,602 to 95th percentile. The same occurred with the frequencies of 2800 Hz and 6000 Hz, with an average of 23,682 and confidence limit of 22,787 to 5th percentile and 24,576 to 95th percentile at 2800 Hz and an average of 24,644 and confidence limit of 22,720 to 5th percentile and 24,567 to 95th percentile at 6000 Hz. The 4000 Hz frequency presented an average of 24,097 and confidence limit of 23,185 for 5th and 25,010 for 95th percentile. **Conclusions:** The results obtained related to DPOAE amplitude may contribute to a more accurate diagnosis of peripheral auditory system alterations.

Does recreational exposure to elevated sound pressure levels impair hearing in young healthy adults?

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Introduction: Nowadays, ear phones are commonly used by the youngsters, as well as leisure exposure to elevated music sounds. For quite a long period of time, research related to noise exposure focused on the relation of noise exposure and acquired hearing loss, diagnosed by tonal audiometry and characterized by cochlear lesion seen as a increase in audiometric high frequency thresholds. Recent research found associations between exposure do elevated sound pressure levels and the presence of structural abnormalities of the auditory nerve, even in individuals with normal audiometric thresholds. The most common audiological finding in peer reviewed literature is reduced wave I amplitude in the auditory electrophysiologic assessment. This condition has been called hidden hearing loss. Tonal audiometry remains as gold standard in the basic auditory assessment and in the monitoring of hearing function in occupational settings, though it doesn't identify this type of auditory nerve lesion. Our concern is that the non identification of hidden hearing loss may mislead guidance and counseling regarding safe levels of exposure and time of exposure. This could contribute to mask and delay proper diagnosis of a probable progressive hearing degeneration. **Objectives:** characterize the audiometric profile, describe the brainstem auditory evoked potentials of young adults (university students) as well as associate this audiological results with listening habits, leisure exposure do elevated sounds and hearing complaints. **Material and methods:** cross-sectional, comparative study, with undergraduate students aged 18 to 25 years. All participants answered a structured questionnaire and were evaluated with tonal audiometry, immittance measures and brainstem auditory evoked potential. Participants were divided into two groups, group A was minimally exposed to ear phones and amplified music and group B was formed by more exposed participants. This was an arbitrary choice to verify if there were differences between higher and lesser dose of exposition. **Results:** Difficulty listening in noisy environments and sound intolerance were the most frequent complaints presented by the participants in both groups. Group B reported tinnitus and had more frequent abnormal acoustical reflexes in comparison with group A. Electrophysiological assessment showed a tendency of poorer results in group B compared to group A, though both groups presented abnormalities, specially mean amplitude ratio from wave V/I. No difference between the groups was observed regarding association statistics. **Conclusions:** results of both groups suggest primary lesion of the auditory nerve and raise concerns regarding the need to identify hidden hearing loss in this population.

Early clinical experience of the Baha® 6 Max Sound Processor in Europe

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Background and objectives: The Cochlear™ Baha® 6 Max Sound Processor is a bone conduction sound processor with the output power required for a 55 dB fitting range. It offers a discreet projection with its LowPro™ snap-coupling and it also features technology that allows direct streaming from both Android phones and Apple devices. To study the acceptance of this new product prior to global launch, a Controlled Market Release (CMR) was run in 3 different countries in Europe. The primary aim was to collect feedback on the overall product experience and perceived sound quality, as well as on the fitting process using the new Baha Fitting Software 6 (BFS6). **Material and methods:** 73 recipients (from across 9 different clinics in The Netherlands, United Kingdom and Spain) were fitted with a Baha 6 Max Sound Processor. The audiologists completed feedback surveys at the time of fitting and during follow-up appointments with the recipients, roughly 2 weeks after the fitting session, over a period of up to two months (follow-up surveys will be collected until end of April). **Results:** From the 73 surveys collected, 15% were referent to initial fittings and 85% to upgrades. 93% of the recipients were fitted with the LowPro snap-coupling, while the remaining 7% were fitted with the Baha 6 Max, 2mm to avoid sound processor contact with soft tissue or hair, and consequent feedback (e.g. due to excess soft tissue around the abutment). All recipients indicated they were satisfied with the Baha 6 Max, highly praising the clarity, naturalness, and richness of sound. The connectivity options and the more discrete design have

also been admired by the recipients. After a couple of weeks of use, recipients continued to demonstrate high levels of satisfaction adding very positive feedback on the sound quality while listening to music and in noisy environments (24 follow-up surveys collected to date). 92% of these 24 recipients (all upgrades) have indicated they feel that Baha 6 Max provides better hearing outcomes compared to their previous device, with the other 2 recipients remaining neutral. On BFS6, for 52% of the fitting sessions, BFS6 was reported to be faster than BFS5 and for 34% it felt easier to use in terms of complexity. For the remaining sessions the software seemed to behave in a similar way to the previous generation software. **Conclusions:** The clinical experiences recorded during this CMR indicate that recipients fitted with a Baha 6 Max sound processor were satisfied with their new sound processor, highlighting that the sound feels natural, clear and rich and shows great quality in noisy environments and while listening to music. Furthermore, for most recipients, Baha 6 Max was preferred over their previous hearing device. On the fitting experience, BFS6 seems to be very intuitive and faster compared to the previous software generation.

Effect of reverberation on auditory working memory

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Adverse effect of reverberation on speech intelligibility has been studied previously by a number of researchers. However, the effect of reverberation on working memory when listeners process auditory signals is not well understood. In this study, we investigated whether reverberation may reduce individual working memory capacity by a behavioral measure, known as sentence-first word identification and recall (SWIR), and pupillometry. The SWIR sentences were presented to the listener at the signal-to-noise ratio corresponding to HINT-95 speech intelligibility and we also measured the synergic effect noise and reverberation on processing spoken words. These tests were conducted in six conditions depending on the degree of reverberation (none, low and high reverberations) and without or with noise (four talker babble). Verbal working memory capacity was also measured using reading span test from individuals. In the SWIR test, after leach set of seven sentences, participants were instructed recall the first word of each sentence as many as they could in any order. We also measured participants' pupil size during sentence encoding. Forty young adults with normal hearing participated in this study. The recall performance in the SWIR decreased as the reverberation became stronger regardless of noise (P<0.005). In all reverberation conditions, as expected, the recall performance was higher in the absence of noise than in the presence of noise (P<0.005). Larger pupil dilations and more delayed latency of peak pupil dilation were observed in high reverberation condition. Reverberation has a significantly adverse effect on working memory capacity, indexed by SWIR performance, even though the speech signals were intelligible. The two factors, reverberation and noise, both appeared to deteriorate individual working memory in our study.

Effects of aging on auditory processing abilities

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Objectives: Many studies have shown that auditory processing abilities deteriorate with age. The auditory processing abilities of the central nervous system should be examined in various processing areas such as temporal processing, dichotic listening, monaural low-redundancy, and binaural interaction areas. The purpose of this study was to investigate the effects of age on auditory processing abilities by examining Korean populations in the age groups of the 20s through 70s with normal hearing sensitivity. **Methods:** Five auditory processing tests, including Speech-in-noise Test (SINT), Compressed-Speech Test (CST), Binaural Fusion Test (BFT), Dichotic Digit Test (DDT) and Frequency Pattern Test (FPT), were used on 128 subjects (divided into six age groups) in the age groups of 20s through 70s with normal hearing sensitivity. Performance on each test was analyzed to examine the changes in auditory processing abilities by age. Correlations between tests were also analyzed. Furthermore, the number of subjects who were below the -2 SD, based on each test result of the age of 20s, were identified to determine the prevalence of suspected auditory processing disorder in each age group. **Results:** The results revealed that the performance decreased in all test areas as age increased from the 20s and 70s, especially significantly declined from the age of 50s. It was indicated that performance decreased from the age 50s in SINT, CST, DDT, and FPT. However, significant performance degradation was found in the age of 60s in the BFT. Significant correlations were found between SINT and CST, and also between DDT and FPT. It showed that as age increased, the number of subjects who scored below at-risk criteria (-2 SD) increased. **Conclusions:** The results of all auditory processing tests proved that central auditory processing functions decreased as a function of age. These findings suggest that it is necessary to establish test standards for ages above the 50s. These data from the study can be used in attribution towards the development of a standardized test, especially to be used for adults and the elderly population in a clinical setting for effective diagnosis and rehabilitation programs.,,

Effects of auditory training via direct streaming to the AudioLink in SSD CI-children on speech recognition

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Introduction: Around 466 mln people worldwide suffer from disabling hearing loss, and 34 mln of those are children In Austria 1–2 children in 1000 are born with a hearing disorder and between 0.1 and 5% suffer from unilateral, called Single-Sided Deafness (SSD) Treating SSD-patients with a cochlear implant (CI), offers significant benefits for speech perception in complex spatial listening environments After implantation, the brain needs time and training to adapt to auditory signals from both sides before speech and environmental sounds become natural again Therefore, this new, different way of hearing necessitates training without involvement of the normal hearing ear Especially the rehabilitation of SSD-children requires regular, daily, hence best at home, training

to ensure success Practice material for auditory training with children is scarce Furthermore, in the case of SSD the normal hearing ear is only covered manually (earplug or similar), which especially at home is often not done correctly and even in clinical settings there is always a certain possibility that the normal hearing ear is active during the exercises, hence the implanted ear is not trained properly The newest generations of implants such as the Synchrony 2 CI, offers an external universal connectivity device, the so called AudioLink This device can be used to connect the externally worn audio processor (AP) with a phone, tablet, TV or other media devices and the auditory stimuli is directly streamed to the implanted ear This advantage is tested for its effectiveness in the here presented study Objectives: In our study, we connected the Tiptoi game to the AudioLink for therapeutic purposes Tiptoi is a digital audio learning system Children can use an electronic pen when interacting with Tiptoi books, games, puzzles, or even a globe The pen has a built-in microphone and the Tiptoi sequence of sounds, noises and words and their assignment in the book is comparable to the speech perception test for adults when repeating words, with the difference that it is tested in a playful way The aim of this pilot study was to test (1) whether children, aged 5–12 years, suffering from SSD accept this training method and (2) whether this training improves the speech recognition after Tiptoi training streamed directly via AudioLink **Material and methods:** 10 implanted SSD patients received Tiptoi training via AudioLink as an additional voluntary therapy intervention The children were asked to practice daily for 10 minutes for a duration of one month Before and after training, the following measurements were performed: Göttinger Children's Language Test WRS (presentation level of 65 dB and 80 dB vs streaming via AudioLink), Tiptoi tasks (recognising 10 sounds and understand 10 sentences), SSQP questionnaire. **Results:** Out of the ten included subjects, seven children already finished the four weeks of AudioLink training at home Based on the diary a daily training of 8 7 minutes was reported The WRS at 65 and 80 dB in aided condition was improved (*P*=0.1 and P=0.05 respectively) Whereas the WRS streamed via AudioLink, ensuring direct auditory input through the implant, was significantly better after training (*P*=0.02) The SSQP Questionnaire showed a significant improvement in the Dimension of Speech and Overall gain (*P*=0.03 and *P*=0.04, respectively) The outcomes of the Tiptoi tasks resulted in a significant benefit in the category "recognition of sounds", while the category "understanding of sentences" only showed tendencies for improvement (*P*=0.02 and *P*=0.12). **Conclusions:** The preliminary results are very encouraging and showing not only the positive uptake of daily training at home but also resulted in significant improvements in subjective as well as objective measures for this rather short training period of only 1 month.

Effects of unilaterally oriented selective attention on auditory evoked potentials in bilateral active listening task – preliminary results

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Objectives: Aim of this study is to assess, by adoption of sustained attention paradigm descripted by Hillyard et al., whether and how auditory attention oriented towards one ear influences auditory processing as seen in evoked potentials at group and individual level. Here results from first pilot iteration are presented. **Material:** Nine healthy, normal hearing adults (5 men, 4 women) have volunteered in applied experimental procedure in presented study. **Methods:** By earphones they listened simultaneously to two oddball tone sequences, one per ear. There were two tasks: attend to left and right ear, counting respective deviant stimuli. Effects of lateralized attention were assessed by comparing auditory evoked potentials elicited by standard stimuli in both attended and unattended conditions. **Results:** At the group level we observed significant change towards negativity in amplitudes of N1, P2, and N2 waves. Further investigation into attended-unattended difference wave shows a sustained negativity in window 70–600 ms. Subject-level results do not always follow the group pattern however. **Conclusions:** Results indicate a strong influence of attention on evoked responses at group level, corroborated by results obtained with similar procedures. Further tuning of stimulus and procedure parameters, including individual setting of task difficulty may be beneficial for robustness of procedure.

Electrophysiological and vascular processing of spoken and sung sentences in cochlear-implant patients compared to normal-hearing subjects

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Objectives: Patients with profound hearing loss can be supported by a cochlear implant (CI) to restore hearing. The development of hearing with CI, especially concerning speech comprehension, is subject to constant changes associated with several plasticity effects in the brain. These neural changes are not completely understood yet. In the present study neural processing mechanisms during speech comprehension of spoken and sung sentences will be investigated in order to assess potential effects of sentence melody. **Material and methods:** Brain activity was assessed via the simultaneous application of two neuroscientific methods: the electroencephalography (EEG) and the functional near-infrared spectroscopy (fNIRS). The former is able to measure very fast modulations in the brain in the range of milliseconds, while the latter can identify increased activity of underlying brain areas. By means of this multi-methodological approach, we assessed brain activity while patients supplied with a cochlear-implant listened to semantically correct and incorrect sentences. Each sentence was presented in a spoken or sung modality. A group of normal-hearing listeners was additionally tested with the same experiment as a reference group. **Results:** Results from EEG as well as fNIRS in normal-hearing subjects show comparable processing for spoken and sung sentences. The EEG, in particular, shows an increased N400 component for semantically

incorrect compared to correct sentences. CI-patients reveal differential amplitudes of specific EEG markers as well as distinct activation patterns in the fNIRS signal. **Conclusions:** First results from this study suggest an affected differentiation ability between semantically correct and incorrect sentences as well as between spoken and sung sentences in CI users. Thus, patients show at least partially altered neural processing mechanisms and brain plastictity effects.

Evaluation of hearing screening of Polish athletes with intellectual disability participating in Special Olympics

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Objectives: Athletes with intellectual disability (ID) have been offered free health screening since 1997, worldwide, by Special Olympics Incorporated (SOI). Such invaluable and informative screening is a part of Special Olympics Healthy Athletes (SOHA) Program developed by International Special Olympics Committee in Washington DC, USA. SOHA program not only hugely benefits athletes with ID (2 million since 1997) but also trains health professionals and students (more 260000 since 1997) to provide such vital health service. Healthy Hearing (HH) is one of the eight parts of SOHA program and has successfully run since 2009 in Poland. The aim of this study is to offer the evaluation of HH screening of Polish athletes during last 10 years as performed by SOI Healthy Athletes Program. **Material and methods:** Healthy Hearing Program has two aims. Firstly, it is designed to test the prevalence of hearing loss in athletes with intellectual disability competing in sport events. Secondly, it is to screen the hearing of athletes participating in sport events and inform them, as well as their coaches, whether the follow-up care is needed. This study concentrates on results from screening of Polish participants in Special Olympics during Summer and Winter National Special Olympics Games between 2009–2018. Healthy Hearing screening included the following sequences: otoscopy, otoacoustic emission (DPOAE), screening tympanometry, screening pure tone audiometry as well as full pure-tone threshold audiometry. During athletics competitions, 500 Polish participants with intellectual disability (ID) were thoroughly examined and their results were statistically analyzed and entered into Polish database included into world database. **Results:** Out of 500 athletes that were screened as part of HH: 75.5% passed the DPOAE screen, 20.2% passed pure tone screening at 25 dB HL, 2.4% passed the pure tone threshold test. They did not require further testing. Approximately 19% of the athletes failed the HH screening. Which means that 81% athletes passed Healthy Hearing Screening Program. 40% of the athletes that passed HH were recommended follow-up laryngological care. Approximately 5% of athletes were detected to have hearing perceptive impairments and 2.5% of them required hearing aids. Further specialistic ENT care and audiological treatment was offered to those athletes. People with intellectual disabilities (ID) present higher risk of having a hearing disorder compared to general population. **Conclusions:** The Special Olympics Healthy Hearing Program which is aimed at screening athletes with intellectual disability (ID) worldwide, including Poland, has been successful at determining and analyzing precisely hearing abilities and providing targeted audiological care to individuals who need it.

Experiences of audiological rehabilitation among individuals with severe to profound hearing loss

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Background: Research on audiological rehabilitation for individuals with severe to profound hearing loss focus primarily on technical aids, in particular on cochlear implants. Not only do research focus on technical aids, audiological rehabilitation increasingly tends to take a medical perspective due to technological advances in the field. Audiological rehabilitation should include other aspect, as described by the Patient Centered Audiological Rehabilitation model (PCAR). The PCAR model includes the following areas of audiological rehabilitation: patient story, self-assessment, communication strategies, technology, work-related interventions, pain and energy related interventions, comorbidities, auditory/visual training including cognitive training, verification and consumer support. **Objectives:** The aim is to describe the experiences of audiological rehabilitation that individuals with severe to profound hearing impairment have found useful in order to function in everyday life. **Material:** Twenty-one adults (≥18 years old) who use spoken Swedish as first language was interviewed. The participants consisted of 4 woman and 17 men, aged ranged between 33 and 88 years of age (mean age 71). All participants had a hearing loss PTA4 ≥70 dB HL on the better ear or scored 50% on speech recognition test on the better ear. The participants had recently been involved in audiological rehabilitation (≤1 year ago). Individuals with cochlear implants were excluded. **Methods:** This is a qualitative study with individual interviews. The participants were recruited from The Swedish Quality Register of Otorhinolaryngology and an invitation for study participation was sent to 102 individuals. Twenty-one individuals accepted to participate in the study and all were interviewed. An interview guide based on the PCAR model was used. The transcribed interviews were analyzed with conventional content analysis. **Results:** The preliminary results of the analysis show that hearing aids are considered helpful when handling hearing impairment in daily life, yet many participants emphasize the need for more information about hearing aids or other assistive technologies. Some of the participants had non-working hearing aids, which was frustrating for them. The personal contact with an audiologist and receiving the support and information they needed are examples of audiological rehabilitation that is considered helpful. All participants were pleased with the personal attention they received from their audiologist or other professions involved in the audiological rehabilitation. One aspect that could be improved is work-related interventions, for example having an audiologist visiting a workplace (work-related intervention) to help finding solutions to difficult communication situations. So even though hearing aids and other assistive technologies were considered important for the participants, the need for work-related interventions is one example of other aspects of audiological rehabilitation that was highlighted by the participants. **Conclusions:** In addition to having well-functioning

hearing aids, the participants emphasize the need for other assistive technologies in order to hear in difficult listening situations such as at their work-place.

Exploring daily-life listening experience: Associations between acoustic factors, heart rate, and self-reported outcomes

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Objectives: The current study investigated how acoustic (i.e., sound pressure level, SPL, signal-to noise ratio, SNR, and type of listening environment, 'soundscape') and user-related (i.e., heart rate, HR, and self-reported listening intentions) factors relate to the everyday listening experience of individuals with normal hearing (NH) and hearing impairment (HI). **Material and methods:** A single-blinded, counterbalanced crossover study design with two participant groups was used. The participants had either audiogram in the normal range or mild-to-severe, bilateral sensorineural hearing losses and at least 6 months of hearing aid experience. A smartphone-based app was used to collect ecological momentary assessments (EMAs). The EMAs were combined with acoustic data logged by the hearing aids as well as HR measurements that were made using wristbands worn by the participants. The participants completed EMAs during a 2-week period in their daily surroundings. During another 1-week period, they simply wore their devices without completing any EMAs. The HI participants were fitted bilaterally with HAs with a single automatic program. The amplification, which was prescribed based on the Voice Aligned Compression rationale, was verified using real-ear measurements. The NH participants were provided with a single HA each that was fastened to their collars. **Results:** In general, the results are expected to show significant associations between both acoustic and user-related factors, and self-reported listening experiences in terms of EMA scores. It is expected to observe lower EMA scores (i.e., less favourable experience of a listening situation) with increased HR in challenging sound environments compared to more quiet surroundings. Furthermore, the results are expected to show an interaction between increased HR and self-reported listening intentions with situations involving speech communication differing from similar situations without any listening intentions. Lastly, the results are expected to show a difference in self-reported listening experiences in terms of EMA scores and HR measurements between the NH and HI participants. **Conclusions:** The hypothesized associations between acoustic and user-related factors and self-reported listening experiences are expected to provide a more detailed understanding of the everyday hearing-health behaviour of individuals with normal and impaired hearing. Ultimately, this could provide a basis for improving HA treatment in clinical practice.

Extended high-frequency audiometry – hearing thresholds in otologically healthy adults

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Objectives: The aim of the study was to determine hearing thresholds in the otologically healthy population with no occupational noise exposure aged 18 to 64 years using extended high-frequency audiometry (EHFA). **Material and methods:** The data of individuals with no history of hearing problems and no workplace noise exposure was collected between 2020 and 2021. They were divided into 5 age categories: 18–24 and further by 10 years of age. All subjects underwent the examination consisting of tympanometry, conventional pure-tone audiometry, and EHFA. The hearing thresholds from 0.125 kHz to 16 kHz were measured. Hearing loss was evaluated based on medians. Statistical comparison of data was performed using basic descriptive statistics, the chi-square test and the Mann-Whitney test on significance level of 5%. **Results:** A total of 316 respondents (i.e., 632 ears) aged 18–64 years were involved in this study, 68% of them were women and 32% men. The effects of age on hearing were evident for all frequencies of 9 kHz and higher for the age category 25–34 years, with statistically significant higher hearing thresholds in each older age group comparing with the previous younger age group. The hearing thresholds higher than 25dB at EHFA were found in the 35–44 years old at 14–16 kHz, in the 45–54 years at 12.5–16 kHz and in the 55–64 years at 10–16 kHz. The ability to detect sounds of EHFA also decreased with increasing age and frequency, the deterioration started at the age between 18–34 years at 16 kHz, in the 35–64 years old group at 12.5 kHz. **Conclusions:** Hearing thresholds at EHFA deteriorated with the increasing age and frequency. EHFA proved to be more sensitive method in detecting hearing loss than conventional pure tone audiometry in otologically normal individuals. The ability to detect sounds on EHFA decreased with increasing age and frequency.

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Extended high-frequency audiometry and risk factors for hearing loss

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Objectives: The aim of the study was to find risk factors of hearing loss in the otologically healthy population with no occupational noise exposure aged 18 to 64 years using extended high-frequency audiometry (EHFA). Material and

methods: The data was collected between 2020 and 2021 in otorhinolaryngological clinic. Individuals from the general population who have never had hearing problems and whose job was not associated with noise exposure were included in the study and classified by age into 5 categories: 18–24 and further by 10 years of age. All subjects underwent conventional pure-tone audiometry (0.125–8 kHz), and EHFA (9–16 kHz). The presence of hearing loss in individuals was defined by fulfilling any of these criteria: pathologic otoscopy, average hearing loss at frequencies 0.5; 1; 2; 4 kHz >25 dB according to WHO, values at frequencies 6 kHz and 8 kHz > values for these frequencies in the standard EN ISO 7029: 2017, Hearing Handicap Inventory results (10 questions) >8 points. A statistical analysis was performed using chi-squared test, Fisher's exact test and binary logistic regression – basic model with adjustment for age and gender and fully adjusted model for age, gender, living alone, education, smoking, BMI, otitis media, blood pressure, sport shooting, type of headphones, listening volume and length of use of the headphones. Statistical tests were evaluated at a significance level of 5% using the SW Stata version 15. **Results:** A total of 497 participants (i.e., 994 ears) aged 18–64 years were included in the study, of which 52% were women and 48% men. According to the pre-set criteria for hearing loss in the studied population, 78 individuals with and 419 without hearing loss were found. Statistically significant differences in hearing loss were found according to age, level of education, use of personal listening devices and its length. The risk factors of hearing loss identified using a binary logistic regression model adjusted for age and gender were as follows: age above 55 years, smoking and the use of personal listening devices on a very loud intensity (grade 8–10). In the fully adjusted model, the use of personal listening devices on a very loud intensity was confirmed the only statistically significant risk factor of hearing loss. These people are up to 3.44 times more likely to have a hearing loss than people who either do not use headphones or listen on lower volume.**Conclusions:** Hearing loss is multifactorial. The most significant risk factor of hearing loss is the use of personal listening devices on a very loud intensity. This finding should be used to prevent hearing loss especially in the younger generation who are exposed to daily use of headphones.

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Facial nerve palsy as a complication after otitis media

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Objectives: To present the complexity of the problem which is the occurrence of facial nerve palsy as a complication after otitis media. **Material:** The material was collected on the basis of medical history, tests results, medical documentation and treatment applied to the 46-year-old patient who was admitted to hospital with diagnosed otitis media in the course which facial nerve palsy occurred. **Methods:** The first performed test was an assessment of the degree of facial nerve damage based on House-Brackmann six-point scale. The ophthalmological examination of the right and left anterior eye segment, computer tomography of temporal bone and pure-tone audiometry test were performed. The treatment involved antromastoidectomy, posterior tympanotomy, drainage of the tympanic cavity and facial nerve decompression on the left side. **Results:** In the patient, the degree of paresis on the right side was classified as I point, on the left side as IV point. In ophthalmological examination, the anterior segment of the right eye – normal, the anterior segment of left eye – the cornea stained with fluorescein partly, its retention was noted. Computer tomography showed features of acute otitis media on the left side, bulging of the tympanic membrane and the presence of fluid in the atrium and cells of the mastoid bone. Foamy discharge has been seen in the maxillary sinus and the sphenoid sinus. No abnormal foci or intracranial bleeding were found within the brain. In pure-tone audiometry, the right ear hearing threshold for air and bone conduction was within normal range. Mixed hearing loss occurred in the left ear for which the pure-tone average (determined at: 0.5, 1, 2 and 4 kHz) for air conduction was 52 dB and for bone conduction (determined at: 0.5, 1, 2 and 4 kHz) 22 dB. The average air-bone gap was 32 dB. **Conclusions:** Quickly applied diagnostic and treatment allowed the patient to fully restore the normal function of the facial nerve.

First confirmation of RMND1 gene as a cause of Perrault-like syndrome

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Objectives: There are different genetic variants located in the RMND1 gene that are causally involved in the development of a mitochondrial disease with complex phenotype including sensorineural hearing loss (HL), hypotonia, developmental delay, lactic academia and renal dysfunction. In 2018 the first and so far the only report on association of RMND1 pathogenic variants with Perrault-like syndrome has been published. **Material and methods:** Patient diagnosed with progressive HL at 4 y.o., hypergonadotropic hypogonadism at 17 y.o. and chronic kidney disease at 33 y.o. and her family members were consulted at the Department of Genetics, Institute of Physiology and Pathology of Hearing. Genomic DNA was isolated from whole blood and buccal swabs samples using a standard salting-out procedure and an automatic method (Maxwell RSC Instrument, Promega, Germany), respectively. Our custom multigene panel (SeqCap EZ choice, Roche, Switzerland) encompassing 237 HL-related genes was used to prepare proband's sample library that was further sequenced on the MiSeq platform (Illumina Inc, USA). All bioinformatics and expert analysis were done and probable pathogenic variants were selected based on their population frequencies (<1%), functional consequences (e.g.:

missense, frameshift, splice-site) and pathogenic predictions (CADD, LRT, FATHHM, MutationTaster, PolyPhen-2, SIFT). **Results:** Genetic testing revealed two novel probably pathogenic c.583G>A (p.Gly195Arg) and c.818A>C (p.Tyr273Ser) RMND1 variants, that were inherited in an autosomal recessive manner from the proband's parents. Identified variants were also present in the DNA sample from proband's sister who has also been diagnosed with HL and primary amenorrhea. Clinical reanalysis revealed that patients have no neurological or intellectual impairment, and nephrological evaluation predicts a benign course of kidney disease. **Conclusions:** Our results represent the first independent confirmation of RMND1 involvement in the development of Perrault-like syndrome and broaden our knowledge on phenotypic presentation of the disease. Considering the probability of mild presentation of renal phenotype in patients with RMND1 pathogenic variant, we strongly recommend inclusion of the RMND1 gene in standard genetic diagnostic process for Perrault syndrome.

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Function of amplitude growth of electrically evoked compound action potential in patients with cochlear implants

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In many patients it was noted that the auditory nerve telemetry (ART) values correspond to the values of the maximum comfortable volume. We suggested a hypothesis that to increase the correlation between ART and MCL, we should take into account the angle of inclination of the growth function (GF) of the amplitude ECAP. **Objective:** To determine whether the correlation between ART and the MCL level depends on the,,inclination angle of the growth functions of the ECAP amplitude. **Material and methods:** 76 patients (*N*=76) with a Concerto cochlear implant (Med-El). All patients underwent ART registration as a function of the amplitude growth of the electrically induced auditory nerve action potential and the values of the ART level for each individual electrode were obtained. The value of the inclination angle of the growth function of the amplitude of the action potential of the auditory nerve was obtained with help of the tangent of inclination angle. The MCL data were obtained with a volume categorization scale. **Results:** The following data were obtained: the minimum inclination of the growth function of the amplitude of the action potential of the auditory nerve was 18 degrees (Tn=0.31). The maximum,inclination angle was 70 degrees (Tn=2.89). In calculating the correlation dependence between the telemetry of the auditory nerve response and the maximum comfortable loudness, we divided the patients into two groups: the first where the inclination angle of the growth function of the amplitude of the action potential of the auditory nerve was less than 45° and the second group where the inclination angle was greater than or equal to 45°. **Conclusions:** An analysis of the data obtained showed that a higher correlation between telemetry of the auditory nerve response and a level of the maximum comfortable loudness occurs if the inclination angle of the growth function of the amplitude of the auditory nerve action potential is greater than or equal to 45°, the correction factor should be added provided that the inclination angle is less than 45°. These data can be used to improve the accuracy of the maximum comfortable,,volume level determination.

Global self-esteem and deafness – the study of the deaf persons using a cochlear implant since adulthood

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Objectives: Self-esteem is considered to be a predictor of mental health and plays a crucial role in person's psychosocial functioning, especially in groups of increased risk of problems in this area, such as people who are deaf or hard-of-hearing. This study aims to find a reply to a question about the level of global self-esteem in hearing-impaired adults with different onset of hearing loss (prelingual v. postlingual) and degree (profound v. partial), who have received a cochlear implant (CI) after 18 years of life in comparison to the general population. Another interesting question is also the relationship between the self-esteem, the deafness- and CI-related variables such as CI satisfaction or the type of hearing prosthesis, and the sociodemographic variables. Until now there are no studies on the level of self-esteem in this population. **Material:** The analysis included 120 adults divided into four groups: adults with profound prelingual deafness (*n*=30), profound postlingual deafness (*n*=30), prelingual partial deafness (*n*=30), and postlingual partial deafness (*n*=30). Study participants were users of one CI implanted after 18 years of life. **Methods:** The study was conducted by mail. The response rate was 64%. Global self-esteem was measured using the Rosenberg Self-Esteem Scale (SES). Sociodemographic data and information related to deafness and CI were collected using own Information Survey. The statistical analysis of the results was done using the comparison of means tests (*t*-test, ANOVA), correlation and linear regression. **Results:** It turns out that the level of global self-esteem of CI users with deafness and partial deafness is significantly lower than in the general population. It is especially true for postlingually deaf adults. The only significant explanatory variable is CI satisfaction: higher CI satisfaction is related to higher self-esteem. Among sociodemographic variables, the most significant explanatory variable for self-esteem of studied persons is the marital/partnership status (being in a relationship), education (higher), and sex (men) – also, people who are professionally active or in education show higher level of self-esteem. **Conclusions:** Deafness or partial deafness is still a factor of risk of lowered self-esteem. Particularly vulnerable is self-esteem of postlingually deafened CI users. In rehabilitation care, different forms of psychological intervention, psychoeducation, and psychotherapy should be dedicated to that group. Studies on self-esteem should also include deaf CI users using the sign language and people who have been growing up using the CI from early childhood.

Hearing health policy in the disabled persons health care network of Minas Gerais, Brazil

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Objectives: We aimed to describe the actions and results of public hearing health policies carried out in the state of Minas Gerais, Brazil, in 2018 and 2019. **Material:** We use information from the national database from the Department of Informatics of SUS (DATASUS) and the database of the Coordination of Health Care for People with Disabilities of the Minas Gerais State Department of Health. **Methods:** We researched the documents and legislations that establish guidelines of the Minas Gerais public hearing health policies to describe its organization in the state. To identify policy outcomes, we researched the production of the following audiology procedures: assessment for diagnosis of hearing loss, selection and adaptation of hearing aids, hearing aid provision, diagnosis tests, neonatal hearing screening tests and cochlear implants. **Results:** the hearing health police began in 2004 following the publication of federal legislation. The hearing health police began in 2004 following the publication of federal legislation that provided for the contract and financing of hearing health services. Currently, the hearing health policy is incorporated in the Health Care Network of People with Disabilities that integrates prevention, diagnosis and rehabilitation actions at different levels of complexity of the Unified Health System (SUS). The hearing health services have a multidisciplinary team of speech therapists, audiologists, otolaryngologists, psychologists and social workers. They are responsible for audiological diagnosis, selection, adaptation and provision hearing aids and hearing rehabilitation therapy. The funding of actions, including the provision of hearing aids and cochlear implants, is responsibility of the federal government. The state of Minas Gerais has a territorial extension of 586,528 km² and a population of 20.87 mln inhabitants. There are 853 cities, distributed in 13 major health regions. The first hearing health service was hired in 2005 and currently the state has 21 services spread throughout its territory. The federal government's annual investment is US$ 9,500,000.00. From January 2018 to September 2019, 30,570 people suspected of hearing loss were evaluated or reassessed in these services. Hearing aid selection and adaptation was performed on 25,405 patients with hearing loss, corresponding to 0.12% of the population of Minas Gerais. 67,597 hearing aid equipment was provided during this period. For the diagnosis of hearing loss, 517,979 tests were performed, including: immittance test, audiometry, otoacoustic emissions, and brainstem auditory evoked potential. In Minas Gerais, after the provision of hearing aind, patients are referred to perform hearing training and rehabilitation at the 452 Decentralized Speech Therapy Services, services closer to their city of residence. Cases of hearing loss with cochlear implant indication are referred to one of the four state referral services. During the study period, 143 cochlear implant surgeries were performed. The state neonatal hearing screening program is funded by the state government. Screening is performed before discharge or outpatient for the first 30 days of life. Currently 43 maternity hospitals are hired in the state, reference for the neonatal hearing screening program. Considering only the period from January to December 2018, 113,523 screenings were performed, which corresponds to 43.5% of live births in the state. **Conclusions:** In this study, we identified that there is a networked organization for access to hearing health in Minas Gerais. A significant number of tests and other hearing health actions are performed with funding from federal and state governments. However, future studies are important to measure if the current organization and funding have been sufficient to meet the demands of the hearing impaired population and whether the rehabilitation process offered has improved the population's quality of life.

Hearing loss among 1st and 6th grade children of primary school in Warsaw, Poland – cohort study

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Background: Hearing disorders disturb the child's perception of sound, as well as the development of speech which in consequence negatively affects the child relations in society. The early detection of hearing impairments in children enables the effective implementation of medical and rehabilitation procedures or preventive treatment. Therefore hearing screening have an extremely important preventive task, being the primary means of secondary prevention. They allow for an early detection of hearing disorders, thus enabling treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. The recognition of the importance of screening programs targeted at these age groups is confirmed by, among others signing of European consensus on hearing, sight and speech screening by European audiological, ophthalmic and speech therapy societies. In recent years, the Institute of Physiology and Pathology of Hearing has implemented many hearing screening programs in the capital of Poland – Warsaw in cooperation with President of Warsaw. **Material and methods:** Analysis was performed on 102,753 results of audiometric screening examinations performed in 7 and 12-year-old children, attending the 1st or 6th grade of a primary school in Warsaw, during 5 school years (from 2014/2015 to 2018/2019). 55.6% of the group was 7 years old. All children underwent tone audiometry hearing examination in frequencies 0.5, 1, 2, 4 and 8 kHz. Tests were performed using the screening device – Sense Examination Platform. Hearing loss was defined as air threshold values of 25dB HL or greater for any frequency at least one ear. **Results:** Analysis of the obtained results of hearing screening showed that the positive result of the audiogram was found in 15,105 children (around 14.7% of the surveyed population). Among children aged 7, the percentage of positive results was 17.7%, while in children aged 12, it was 11%. In addition, there was a large number of unilateral hearing losses. **Conclusions:** Any loss of hearing sensitivity constitutes a major barrier to effective learning as all formal learning activities in school environments are mediated through the sense of hearing. Hearing screening programs should be initiated for school-aged children to support equal educational opportunities for children who suffer from

communication disorders. The school-age hearing screening has been shown as an effective and accessible mean of identifying impairments that were not diagnosed until school-age, as well as those developed during this period, fulfilling its objective to minimize the difficulties and losses due to hearing deficits. The presented results once again confirm the need to implement routine hearing screening among school children. In accordance with the adopted rules of programs implemented by the Institute of Physiology and Pathology of Hearing, children are immediately referred for detailed examinations to local specialists in order to undertake proper treatment.

Hearing preservation of adult cochlear implant users with Partial Deafness – one year follow up after using different regimes of steroids therapy

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Objective: The objective of this prospective clinical study was to assess the influence of different regimens of steroid therapy on preservation of hearing following cochlear implantation. **Material:** Into the study we included participants aged ≥18 years, with hearing sound levels in the range of 10–120 decibels (dB) and sound frequencies of 125–250 hertz (Hz); sound levels of 35–120 dB and frequencies of 500–1,000 Hz; sound levels of 75–120 dB and frequencies of 2,000–8,000 Hz. Study exclusion criteria included diseases with contraindications for steroid therapy or medications that increased the effects of steroids. **Methods:** Patients were qualified to cochlear implantation and were divided into three treatment groups: IV steroid therapy (standard steroid therapy): combined oral and IV steroid therapy (prolonged steroid therapy); and a control group (cochlear implantation without steroid therapy). Hearing preservation was established by pure tone audiometry based on the pre-operative and postoperative average hearing thresholds according to the formula developed by the HEARRING Network. **Results:** According to Hearing Preservation classification patients from the prolonged steroid therapy group achieved the best results of hearing preservation. The complete hearing preservation index was observed in the highest percentage of patients from this group. The dispersion of measured values was lesser in comparison with other subgroups, showing the stability of obtained results. **Conclusions:** Combined oral and IV steroids therapy enables stabilization of hearing thresholds to the biggest extent and, by doing this, preserves hearing in adult patients with partial deafness who underwent cochlear implantation.

Hearing preservation outcomes after cochlear implantation depending on the length of electrodes in patients with partial deafness

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Objectives: To evaluate the impact of electrode length on hearing preservation (HP) in a selected group of adults with Partial Deafness Treatment-electric complementation (PDT-EC) receiving one of two kinds of flexible electrodes: the longer 24 mm electrode array or shorter 20 mm electrode array. **Material:** Twenty-three PDT-EC patients (with preoperative air-conduction thresholds ≤30 dB up to 500 Hz) were divided into two groups: Flex20 electrode (Med-EL GmbH, Innsbruck, Austria) (12 patients) and Flex24 electrode (Med-EL GmbH, Innsbruck, Austria) (11 patients). The mean of age of patients with Flex20 at the time of surgery was *M*=49.6 years (standard deviation, *SD*=15.5) and *M*=52.8 (*SD*=15.2) for patients with Flex24. **Methods:** Hearing threshold measurements were conducted on all patients five times: preoperatively, 1 month after the operation (at activation), 6 months after the operation, 12 months after the operation, and 24 months after the operation. HP was established using the HEARRING group formula. The Pruszewicz monosyllabic word test was conducted in free-field at the preoperative period under unaided and aided configurations (with hearing aids) under the best conditions. All participants were subjected to minimally invasive cochlear implantation using the round window approach. **Results:** Analysis of HP for every individual indicates that more than half the patients with Flex20 and Flex24 had complete HP at 6 months follow-up. None of the patients from either group had complete loss of hearing. At activation, average air-conduction thresholds for low frequencies (125–500 Hz) were slightly better for the short electrode (*M*=29.03) than for the long (*M*=39.10) but the difference was not statistically significant (p=0.067). The effect of electrode (Flex20 versus Flex24) was not significant in terms of pure tone audiometry and speech recognition at long-term follow-up. **Conclusions:** In early postoperative observations, complete HP was possible in the majority of patients from both groups, although slightly better HP outcomes were achieved by the Flex20. In the long-term, however, the electrode length (20 or 24 mm) does not affect the degree of HP or speech understanding, at least in the hands of an experienced otosurgeon. Considering that HP is also possible using a deeply inserted long electrode array, and that most patients have progressive hearing loss, the use of a longer, flexible electrode seems to be a better choice.

Impact of hearing aid technology level on reported outcomes in older adults with presbycusis: a randomized controlled trial

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Objectives: Hearing aids are the most common rehabilitation choice in older adults with presbycusis. However, the choice of the technology level today is somewhat arbitrary and typically based on individual preferences. Thus, independent research supporting the choice of hearing aid technology level for older adults with presbycusis is lacking. Therefore, the main purpose of the current study was to assess the perceived hearing abilities and the reported effectiveness of hearing aids for adults with presbycusis using premium-feature or basic-feature hearing aids. Secondly, we investigated if differences in gain prescription measured with real-ear measurements explain potential differences in self-reported hearing aid outcomes. **Material:** Two types of self-reported questionnaires were used: the Inter-national Outcome Inventory for Hearing Aids (IOI-HA) and the abbreviated form of the Speech, Spatial, and Qualities of Hearing Scale (SSQ-12) questionnaire. In addition, insertion gain at first fit was measured for all fitted hearing aids using real-ear measurements. **Methods:** The study was designed as a two-arm parallel randomized controlled trial embedded in a Danish national Better hEAring Rehabilitation (BEAR) project. In total, 190 first-time hearing aid users (≥60 years) with symmetric bilateral presbycusis were randomly allocated to either a premium-feature or basic-feature hearing aid from one of the three hearing aid manufacturers contributing to the BEAR project. The randomization was stratified according to age (60 to 69 years, 70 to 79 years, 80≥ years), sex, and word recognition score (WRS≥80% and WRS<80%). **Results:** Premium-level hearing aid users (n=93) re-ported 0.8 (95% CI: 0.2;1.4 p=0.01) scale points higher SSQ-12 speech score per item and 0.64 (95%CI: 0.2;1.1 p<0.01) higher SSQ-12 qualities of hearing score per item compared to basic-level hearing aid users (n=97). With the IOI-HA questionnaire, there was no statistically significant difference in reported hearing aid effectiveness between the two levels of hearing aid technology. Higher gains at 1 and 2 kHz were observed in premium hearing aids compared to basic hearing aids with two of the hearing aid manufacturers, but the opposite was found for the premium and basic hearing aid from the third hearing aid company. However, the variations in gain did not explain the reported differences in hearing aid outcomes. **Conclusions:** Premium hearing aid users reported significantly better hearing abilities in the speech and qualities of the hearing domain compared to those using a basic-feature hearing aid. Thus, the study found evidence to suggest that adults with presbycusis may benefit from using premium-feature devices. However, the statistically significant difference in reported outcomes found in this study might not be clinically relevant for all, so clinicians should be careful to conclude that premium devices always yield improved outcomes for older adults with hearing loss.

Implantation of two generations of Bonebridge after mastoid obliteration with bioactive glass S53P4

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Patients with chronic otitis media with cholesteatoma are often treated with canal wall up or, in advanced stages of the disease, radical (canal wall down) mastoidectomy. The presence of a postoperative cavity causes an accumulation of epidermis, recurrent inflammations, and some restrictions on wearing hearing aids. The aim of the study was to report preliminary results of 2 stage surgical technique, involving obliteration of the mastoid cavity after canal wall down mastoidectomy and Bonebridge implantation. Study was based on 16 adult patients who had had a history of chronic otitis media with cholesteatoma in one or both ears and previous canal wall down mastoidectomy. The patient's medical history, healing, audiometric results, and benefits from Bonebridge device were assessed. During the follow-up period, we did not notice any serious postoperative complications. Studies demonstrated significantly improved hearing thresholds and speech recognition in quiet and noise using the Bonebridge BCI 601 (7 cases) and Bonebridge BCI 602 (9 cases). Summarizing, we believe that the proposed two-stage surgical method using bioactive glass S53P4 is a safe and effective way of implanting both generations of the Bonebridge in difficult anatomical conditions.

Improving speech understanding in patients after cochlear implantation after replacing the speech processor with a new one

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The cochlear implant treatment program was established in our Department in 2004. We have implanted almost 200 patients aged 4 to 87 years (average age 45) within 15 years. The profound hearing loss and deafness treatment program also includes replacing the speech processor with a new one in the event of its failure and the service life exceeding 5 years at the same time. At present, we have carried out exchanges with almost 120 patients with implants from various companies. After

the exchange, subjective evaluation was carried out as part of surveys assessing the quality of life of patients after replacing the speech processor. Speech understanding in free field in noise was also assessed. The obtained results allow us to state that the patient's quality of life after replacing the speech processor with a new one increases. Speech understanding improves in approximately 70% of patients. Failures are associated with the lack of rehabilitation and sufficient use of the processor by the patient.

Injection reaugmentation in patients with unilateral vocal fold paralysis – one year follow up

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Introduction: Unilateral vocal fold paralysis (UVFP) occurs approximately in 0.41–0.51% of the population with voice detorioration presented in 83.6% of cases. The treatment of UVFP is mainly focused on restoration of the and include voice therapy and surgical procedures. **Material and methods:** The study group consisted of 27 patients who underwent injection laryngoplasty (reaugmentation) due to unilateral vocal fold paralysis. The mean age was 62.59 years and the mean period from first augmentation was 3 years. The patients had laryngological and phoniatric examinations before surgery, 6 and 12 months after treatment. We performed videolaryngostoboscopy, perceptual voice assessment with GRBAS scale, objective acoustic analysis and self-evaluation with Voice Handicap Index-30 questionnaire. All patients were treated surgically with injection laryngoplasty. We used two materials: Surgiderm 24 XP (Allergan) and Radiesse Voice Implant (Merck). The goal of the study was to characterise the group of patients who underwent reaugmentation procedure due to UVFP in 1-year follow up period. **Results:** As concerns glottal gap, 6 months after injection 70% of patients had complete glottal closure and after 1 year – 59%. Moderate glottal gap we observed only in 4% and 4.5% of patients (6 and 12 months periods). No one had severe glottal gap after treatment. The assessment of GRBAS scale showed improvement in terms of all parameters, especially in B parameter – 65% of patients had no breathiness in voice 6 months after surgery and 42% after 1 year. The objective voice evaluation showed improvement mostly among frequency and amplitude parameters, and noise parameters as well. We observed a decrease of values after 6 months, and further improvement after 12 months. Concerning VHI-30 we observed relevant improvement 6 months after surgery and stable score 12 months follow up. **Conclusions:** Injection laryngoplasty is effective treatment method in UVFP. In all cases of reaugmentation we observed good voice results in 12 months after sugery.

Integrating click-auditory brainstem response and pure-tone audiometry results – a case report

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Introduction: Auditory Brainstem Response is an objective exam of choice among the methods that support the inference of the level of hearing in addition to the verification of the integrity of the auditory pathway. **Objectives:** to verify the relationship between the electrophysiological examination and pure tone hearing thresholds. **Resumed report:** a 27-year-old female patient with complaints of difficulty in understanding attended a private clinic and had her hearing assessed using auditory brainstem response with click stimulus at an intensity of 80 dB nHL and pure tone audiometry at frequencies from 0.5 to 8 kHz. The electrophysiological auditory findings with click stimulus had their latency values for waves I, III and V within normality in both ears. While the tonal audiometry findings, by air and bone, pointed to a mild hearing loss with ascending configuration in both ears. **Conclusions:** The accuracy of objective and subjective examinations seems to be strongly related to the concept of crosscheck that must be applied in clinical practice to precisely define the results of assessments and their consequences.

Investigation of the relationship between verbal working memory, short-term memory and speech-in-noise perception in children with cochlear implants

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Objectives: The aim of this study is to evaluate verbal working memory capacity, short-term memory, and speech-in-noise recognition skills in children with cochlear implant and to examine the relationship between these skills. **Material and methods:** Eighteen cochlear implant users aged between 7–10 years with prelingual hearing loss were included in the study (mean age: 105.94 ± 9.62 months). Demographic data of the participants were recorded and audiological evaluation was performed. After that, speech discrimination test was applied at +5 dB and 0 dB signal-to-noise ratios (SNRs). Five subscales of the Working Memory Scale were administered to assess verbal working memory capacity and verbal short-term memory. Backward Digit Recall and First Words Recall subscales were used to assess verbal working memory capacity, while Digit Recall, Word Recall, and Nonword Recall tests were used to evaluate verbal short-term memory. **Results:** A statistically significant correlation was found between verbal working memory capacity and speech discrimination scores under +5 dB SNR condition (r=0.421, p<0.05) and 0 dB SNR condition (r=0.602, p<0.05). A high statistically significant correlation was observed between verbal short-term memory scores and speech discrimination scores under +5 dB SNR (r=0.677, p<0.05) and 0 dB SNR condition (r=0.633, p<0.05). When children implanted before two years of age and those implanted after two years of age were compared, early implanted children were found to be advantageous in terms of verbal working memory capacity and speech discrimination test results at 0 dB SNR (p<0.05). **Conclusions:** Any mismatch between the perceived auditory signal and

stored phonological representations disrupts lexical access. Consequently, effortful processing mechanisms grounded in verbal working memory capacity are used. As mismatches increase, listening becomes more effortful. Acoustic properties of sound, as well as auditory, linguistic and cognitive systems, are effective on these mismatches. According to our results, verbal working memory capacity and verbal short-term memory play a role when children with cochlear implants have to process speech under acoustically adverse conditions.

Korean time-compressed speech test

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Objectives: Monaural low-redundancy speech recognition paradigms, presenting degraded speech to one ear, assess the recognition of degraded speech, in which redundancy is reduced by filtering, time compression, interruption, or reverberation. Assessing this ability is relevant to detect brainstem and cortical lesions; in addition, these tests are useful to quantify central auditory dysfunction and rehabilitation planning. Currently, in Korea, diagnosis and rehabilitation for central auditory processing disorders are inadequate for lack of valid and reliable behavioral tests. Therefore, the purpose of this study was to develop a time-compressed speech (TCS) test of Korean monosyllabic word lists for evaluating the recognition of rapidly changing speech of central auditory system. Moreover, age effects and normative data for both pediatric and young adult populations were shown for clinical use. **Methods:** Two experiments were conducted; Experiment I was conducted to define a compression ratio and a select word list for the TCS test. The Korean monosyllabic lists (KS lists and H lists) were used to assess word-recognition performance in 20 adults and 36 school-aged children with normal hearing sensitivity. The words were presented at 50 dB HL in four time-compressed conditions (45, 55, 65, and 75%). Furthermore, the sub-list equivalency of the each list was examined with the compression ratio of 65%. Experiment II was performed to collect normative data for the time-compressed speech test, percent correct recognition at 50 dB HL was measured on a sample of 270 children (aged 7~12 years) and 107 young adults (aged 20~29 years). **Results:** In Experiment I, as the compression ratio increased from 45% to 75%, recognition performance decreased significantly from 88.00% to 29.67% for the KS lists and from 93.60% to 39.00% for the H lists. There were no significant recognition differences between the two lists. Second, the four sub-lists of each word list for adults under the 65% compression ratio revealed no significant differences in the recognition scores, thus confirming the equivalency of each word list. The conditions that met about 70~80% correct word-recognition performance were between 45% and 55% for adults and below 45% for children. In Experiment II, for the pediatric groups, the mean percent correct scores were 78.43±10.90% for the right ear and 78.93±9.78% for the left ear. For the adult group, the percent correct scores were 84.67±8.77 and 86.77±7.17% for the right and left ears, respectively. An analysis of variance showed that there were no significant differences on ears and genders. Significant developmental trends were seen between ages of 7 and 20's. **Conclusions:** This study showed that the word recognition performance decreased as time-compression ratio increased for both adult and pediatric groups. The recognition performance of children was significantly lower than adults in all compression ratios. In the present Korean compressed speech test, the 45% compression ratio showed appropriate ranges for both pediatric and adult samples. Furthermore, a developmental trend was observed between ages of 7 and 20's; thus, age appropriated norms should be used for interpretation.

Listening effort within an auditory and auditory-visual speech context

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Objectives: Listening effort can be defined as the attentional and cognitive effort to understand speech (Pichora-Fuller et al., 2016). Speech understanding is a multisensory auditory-visual process whereby visual and auditory information is integrated. Visual information from mouth movements (i.e. lip reading), face expressions, and body language is integrated with auditory information in order to increase intelligibility over unisensory speech processing (Massaro & Cohen, 1983; McGurk & MacDonald, 1976). Hence, it was hypothesized that the amount of listening effort will be less in an auditory-visual compared to an auditory speech context. **Material and methods:** Twenty young-adults (range 18–29 years) and twenty older-adults (range 50–69 years) with age-appropriate hearing took part in the study. A dual-task paradigm was used to evaluate behavioral listening effort in diverse listening conditions (i.e. quiet, favorable noise, and non-favorable noise conditions) in both an auditory and auditory-visual speech context. Specifically, a primary speech understanding task (auditory and auditory-visual) and a secondary visual memory task were performed separately (baseline) and simultaneously (dual-task). Listening effort was calculated as the change in visual memory performance from the baseline condition to the dual-task condition (Listening effort =100*(score in baseline condition – score in dual-task condition)/score in baseline condition) (based on Kemper et al. (2009)). **Results:** Based on descriptive analyses, the amount of exerted listening effort increased when the listening condition became more taxing in both the auditory and auditory-visual speech context. Moreover, young-adults showed less listening effort compared to older-adults in both the auditory and auditory-visual speech context. Last, young- and older-adults exerted less listening effort in the auditory-visual speech context compared to the auditory speech context. The latter was greatest in the non-favorable noise condition. A more thorough statistical analysis will be conducted and presented through a poster at the World Congress of Audiology. **Conclusions:** Incorporating visual information from mouth movements might be effective to diminish listeners' amount of listening effort. Further research should investigate the effect of listeners' lipreading ability and cognitive performances on the amount of exerted listening effort in both an (auditory)visual speech context.

Medial olivocochlear reflex in children aged 5 to 7 years

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Objective: The aim of the study was to evaluate Medial Olivocochlear (MOC) reflex in the same children at two different times: 5 years old and 7 years old. **Material:** This study was approved by the institutional ethics committee (protocol 211/12). Twenty children participated, being 7 girls and 13 boys. The study was longitudinal and all audiological assessment was performed on the same children at two different times: at 5 years and then at 7 years. All children underwent pure-tone audiometry, speech tests (speech reception threshold and word recognition), tympanometry, middle ear muscles reflexes, transient evoked otoacoustic emissions (TEOAE) recording, and MOC reflex testing. The inclusion criteria were: 5-year-old children in the first assessment and with hearing thresholds less than or equal to 15 dB HL in pure-tone audiometry (0.25 to 8 kHz in octave intervals). Children with type C or B tympanograms in any of the assessments and children with no TEOAE in any ear were excluded. **Methods:** After pure-tone audiometry and acoustic immittance measurements, the children underwent TEOAE with nonlinear click at 80 dB peak one ear at a time. The MOC reflex test was performed by recording TEOAE with linear click at 60 dB peak in the presence of contralateral acoustic stimulation (CAS). The contralateral stimulus was white noise at 60 dB SPL presented alternately with the absence of noise every 10 seconds until completing 260 sweeps. At the end of 260 sweeps the records obtained without CAS were added separately from the records obtained with CAS and the overall response for each condition was tabulated in a data sheet. The response obtained by the equipment in dB was converted to micropascal and from these the results were transformed into percentage of TEOAE response reduction according to the following mathematical formula: [(TEOAE without CAS – TEOAE with CAS)/TEOAE without CAS]×100. Data were statistically analyzed and comparisons were made between ears and between ages. **Results:** On average, children at 5 years of age present a reduction of 11.7% in the right ear and 7.7% in the left ear without statistical difference. At 7 years of age this reduction is 13.9% for the right ear and 8.6% for the left ear with statistical difference. In the comparison between ages there was no significant difference for either right or left ear. **Conclusions:** The difference in MOC reflex between the right and left ears is more evident at 7 years of age when compared to the records obtained in the same children at 5 years of age. This suggests that the right ear advantage in MOC reflex develops over the years.

Mental distress and deafness – the GHQ-28 questionnaire study of the adult cochlear implant users with partial or profound deafness

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Objectives: Deafness is considered to be one of the risk factors for mental health problems. In Poland, there are no studies on the intensity of psychological distress in the population being discussed, especially in the group of cochlear implant (CI) users. The aim of the study is to assess the intensity of psychological distress in CI users divided into groups according to the type of deafness (prelingual v. postligual) and its degree (profound v. partial) and to compare it to the general population norm. **Material:** The study included 176 persons with different types of deafness, using one cochlear implant, fluent in Polish phonic language. **Methods:** It was performed using the Polish version of the GHQ-28 questionnaire and the information survey. **Results:** The results show that CI users with partial deafness experience higher intensity of overall psychological distress, as well as somatic symptoms, symptoms such as anxiety and insomnia, derangement of the daily functioning, and depression symptoms compared to the general population. By contrast, CI users with the profound deafness acquired postlingually have obtained results (GHQ-28) on the same level as the general population, and the results of the prelingually deaf CI users demonstrate a lower level of overall psychological distress and lower intensity of somatic symptoms and problems in daily functioning. **Conclusions:** The highest level of psychological distress characterizes people with partial deafness using CI, and especially this group requires psychological intervention. At the same time, it may be surmised that in some people with profound deafness the relatively low level of psychological distress shown by the GHQ-28 results is related to the denial coping strategy, which this group of people uses significantly more often than the general population, as shown in other studies. It means that these persons require an individual clinical psychological diagnosis followed by propositions of different forms of psychological and/or psychiatric intervention. Also, deaf persons with different levels of language skills in Polish and/or sign language should be involved in similar studies, as well as people whose first language is the Polish sign language who have become CI users.

Methods of cochlear implants fitting

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Objectives: Cochlear implants are a globally recognized method of treatment of deafness and severe to profound sensorineural hearing loss. Proper patient selection (also disqualification of those who would not benefit from implantation) and correct sound processor fitting are crucial in optimal use of cochlear implant. **Material:** The design was data on the ECAP thresholds (t-NRT) as well as the behavioural T- and C-levels have been collected in CI patients of a otologic referral centres. **Methods:** There was a study sample of CI patients

implanted and fitted in 2 referral centres. Examined patients were users of the Neuro Zti EVO electrode array, Nucleus 24RECA (Freedom) or Nucleus CI512 cochlear implants with the Contour Advance-of- Stylet electrode. **Results:** The authors presented a behavioural adaptation of the threshold profile (MAP) created on the basis of intraoperatively measured electrophysiological parameters. They described different methods of CI patients users like streamlined fitting, automated fitting or tele-fitting. **Conclusions:** Matching speech processors is tedious and time consuming, requires commitment specialist and patient visits to the center, which is often in a distant place from his place of residence. Intensive research is still underway to increase efficiency set up processors and reduce related costs.

Middle latency auditory evoked potential in adults with complaints of central hearing processing

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Objectives: To analyze the latency values of the middle latency auditory evoked potential components and the presence of ear and electrode effects in adults with complaints of central auditory processing disorder. **Material:** Subjects were assessed by pure tone audiometry, immittance and middle latency auditory evoked potential. **Methods:** Thirty-six individuals of both sexes, aged 18 to 55 years, with normal psychoacoustic thresholds and middle ear without alterations, and with complaints of central auditory processing disorder, were part of the study. Initially, all underwent a structured audiological anamnesis to identify auditory and auditory processing complaints. Subsequently, they performed the complete pure tone audiometry and the electrophysiological evaluation through the middle latency auditory evoked potential. Individuals with tinnitus, historic of middle ear alterations, neurological and metabolic diseases and those who made or use alcohol and drugs were excluded from the study. Data were described as means and percentages. **Results:** The middle latency auditory evoked potential presented normal latencies for the Na and Pa component and increased latencies for the Nb and Pb components in the analyzed leads C4A2/C3A2 and C3A1/C4A1. Regarding the analysis of the amplitude of the Na-Pa complex, the exam was altered in 16.60% of individuals with complaints of central auditory processing disorder. There was the presence of the right and left ear effects, indicating changes in acoustic processing for tonal sounds. There wasn't the presence of the electrode effect. **Conclusions:** Middle Latency Auditory Evoked Potential detected alterations in the central auditory nervous system in adults, indicating that it may assist in the diagnosis of central auditory processing disorder.

Mobile applications in teleaudiology – possibilities of application and their effectiveness

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Due to the growing interest in new technologies, mobile application developers have created a number of tools that may be potentially useful in clinical practice as well. More and more applications are being introduced in the field of audiology, used for example in the assessment of hearing or helpful in reducing the severity of tinnitus. Are these new tools for telemedicine? What can be their uses? What is their effectiveness? These and many other questions are born as their popularity increases. In order to be able to answer at least some of them, the team from the Institute of Physiology and Pathology of Hearing decided to test a few selected tools. The aim of the study is to present the possibilities and efficiency of selected mobile phone applications that can be used in audiology. Applications that can be installed on mobile phones with the Android system were selected for testing. The first one allows you to independently perform a hearing screening test, while the second one is designed to support patients in tinnitus therapy. Applications were evaluated in terms of effectiveness, usability, ease of use and satisfaction with use. Application ratings based on surveys and questionnaires. The exact results obtained from the tools will be presented during the conference. In addition, an application model for calling emergency services by deaf people will be presented. Phone applications are a relatively new invention that people of all ages enjoy. The possibility of their application in everyday medical practice is a relatively new field of research in the field of audiology. Current data suggests their effectiveness in different hearing-related domains. In order for created tools to fulfill their functions, one of the tasks of telemedicine should be to oversee emerging applications, determine their effectiveness and cooperate with specialists in a given field in the process of creating new tools.

New possibilities for diagnostics with posturographic equipment

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Objectives: Human posture aim to keep the body balanced when performing work or everyday static or dynamic activities. Posturology, founded in the second half of XX century, is the science for posture. It continuously gains more acknowledgment nowadays. Science for posture enhances the knowledge about connections with other systems of the human organism – ocular, vestibular, auditory, stomatognathic. **Material:** A group of adult patients from different age groups with a hearing loss is presented. They were tested with the newly installed at the Audio-vestibular and Sleep laboratory in Medical University – Varna's University medical and

dental center GPS Posturographic system. All patients filled out questionnaire forms and signed written informed consent forms. **Methods:** All included patients were informed in details for the proposed examination methods. All signed written consent forms. Audiometry, tympanometry and OAE-tests were done. Apart from them, we tested patients' posture and balance on the GPS platform under different modalities – with open/closed eyes, with open/closed mouth, with teeth clenched, with head turned or tilted right/left. All patients received a dental check-up to assess occlusion and dental status as well. **Results:** Changes in posture and balance were observed in the clinical group of patients. Reduced hearing capabilities, although not alone, have an impact on the balance and correct posture of the studied individuals. Other factors, such as malocclusions and their implications on posture and balance were studied as well. **Conclusions:** Implementing different examination methods can only enhance and aid the diagnostics and help the clinician to prescribe adequate treatment for the specific clinical case. An important target for the specialists in the field should always be participating in multidisciplinary medical teams in order to present their patients with the best possible diagnostic and treatment service.

Newborn hearing screening 5 years' results

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Introduction: In 1000 healthy babies, 1 to 3 have hearing loss but this incidence increases to 20 to 40 if we consider high-risk indicators newborns. Newborn hearing screening is important to detect all the babies with hearing loss ≥35 dB, allowing an early detection (before 2 months of age) and adequate intervention/rehabilitation before 3 months of age, if hearing loss is present. **Objective:** To characterize, for the period of 5 years, the newborns population, in a Portuguese central hospital (Centro Hospitalar Universitário de Lisboa Central – CHULC) between 1 January 2016 and 31 December 2020. **Methods:** Considering the risk indicators defined by the Joint Committee on Infant Hearing (2019), the screening is done with Otoacoustic Emissions (OEA) and Automated Auditory Brainstem Response (aABR). Children referred to diagnostic evaluation perform tests such as 1000 Hz tympanometry, ABR and behavioural audiometry. **Results:** In the last 5 years, there were born 17838 babies on CHULC maternity and, in all these years, it was reached the effectiveness level >95%) for a newborn hearing screening program. Diagnostics tests confirmed hearing loss in 50 children, 32 of those are already using some kind of impairment for auditory brain stimulation (22 with hearing aids and 10 with cochlear implants). **Conclusions:** The fact that more than one third of the children diagnosed with hearing loss do not have known risk indicators increase the importance of these hearing screening programs.

Noise exposure effects on physiological and perceptual measures of the auditory system

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Introduction: College students with normal hearing and a history of high noise exposure have recently been reported to have deficits in speech perception in noise and heightened reactions to sound consistent with hyperacusis. Technology use such as personal music player use, and common student activities including noisy leisure activities, affect noise exposure but evolve rapidly preventing reasonable generalization of noise exposure studies with data from students who have long since graduated from applying to contemporary students. There is a dearth of studies analyzing the influence of contemporary college students' high noise exposure on physiological and perceptual tests of auditory system functioning. Understanding college students' noise exposure and associated deficits in auditory functioning will provide evidence for how noise exposure affects their auditory system, and show the need for hearing conservation programs for collegiate musicians and other high exposure but under protected groups. **Objectives:** This study will investigate the association between noise exposure among contemporary college students and deficits in extended high frequency auditory thresholds, outer hair cell functioning, and speech perception in noise. The first aim is to show the effect of noise exposure on extended high frequency audiometry, because noise exposure effects appear on extended high frequency audiometry before traditional audiometry. The second aim is to show the effect of noise exposure on outer hair cell functioning via distortion product otoacoustic emissions (DPOAEs) because DPOAEs are sensitive to damage from noise exposure before that damage appears on other clinical tests. The third aim is to show the effect of noise exposure on clinical and self-reported speech in noise measures to show the real-world impact of auditory system dysfunction on activities of daily living. **Material and methods:** In phase one, a digital questionnaire was distributed containing informed consent, standard case history questions about general and hearing health, and the Noise Exposure Questionnaire (NEQ) to determine level of noise exposure. The NEQ was chosen to measure noise exposure because it collects information about exposure from many sources over a full year, and because of its validation and widespread use by researchers around the world. In phase two, participants will be divided into groups based on their noise exposure and measures more sensitive to subclinical hearing symptoms than conventional hearing testing will be used to show participant's level of auditory system functioning. Extended high frequency (9 to 16 kHz) audiometric thresholds will be measured. Next, distortion product otoacoustic emissions will be collected at traditional frequencies (1 to 6 kHz) and extended high frequencies (8 to 12 kHz), to provide an objective measure of inner ear functioning. Then, the QuickSIN test will be used to quantify speech in noise understanding in laboratory conditions. Finally, the Speech Spatial Qualities (SSQ-12) questionnaire will be used to show the perceived speech in noise understanding during activities of daily living. **Results:** The anticipated results of this study will show that high noise exposure is negatively correlated with physiologic and perceptual measures of auditory functioning in college students with normal hearing. Noise exposure is expected to be inversely related to speech in noise understanding clinically and in the real world, with DPOAE robustness, and with extended high frequency audiometric thresholds. **Conclusions:** College students exposed to high levels of noise can have deficits in speech perception in noise. This study will show the relationship of noise exposure with deficits in the functional use of hearing. Understanding college students' noise exposure and associated deficits clarifies the risks of high noise exposure and shows the need for hearing conservation programs.

Non-hearing sensations in patients with a cochlear implant

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In some cases, after cochlear implantation, in addition to auditory sensations, 'non-auditory' sensations may also occur. Such sensations include pain, dizziness, twitching of the facial muscles, etc. Most often, such complaints can occur in patients with an anomaly in the development of the middle and inner ear, auditory nerve, after injuries of the temporal bone, brain, after meningitis, with autoimmune diseases. They can also be a consequence of the peculiarities of the operation of cochlear implantation (incomplete introduction of the electrode into the cochlea). We analyzed the data of 15 patients from 7 to 72 years old, after CT, with concomitant 'non-auditory sensations'. Were compared – the nature of complaints, anamnesis data, features of the etiology of the disease. The features of audiological indicators, data of X-ray studies were also studied, the results of intraoperative testing were compared. The features of the speech processor adjustment in this category of patients were revealed. In the latest models of CI systems, it became possible to use 3-phase stimulation. It allows you to reduce the threshold for facial nerve stimulation by 30–40%. As a result, the patient can partially or completely get rid of the 'non-auditory' sensations caused by electrical stimulation. As a prophylaxis of such phenomena, it is important to carefully select the electrode at the preoperative stage. Modern high-tech data processing systems for computed tomography of the cochlea make it possible to calculate the type of electrode array as accurately as possible, thereby preventing the risk of incomplete insertion of CI electrodes.

Otoprotection by N-acetylcysteine during cisplatin chemotherapy: a systematic review with meta-analysis

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Introduction: Cisplatin is a widely used against câncer and can lead to hearing loss due to reactive oxygen species (ROS) production. The use of otoprotectors during chemotherapy treatment emerges as a new preventive strategy to reduce hearing loss. **Objective:** To investigate whether N-acetylcysteine has an otoprotective effect in patients receiving cisplatin. **Material and methods:** An electronic search was conducted in the PubMed, Cochrane Clinical Trials, ScienceDirect, ClinicalTrial.gov, LILACS, Scopus, Web of Science, Circumpolar Health Bibliographic Database, Scielo, OPENGREY.EU and DissOnline.de databases, through May 2019. The eligibility criteria included clinical trials that evaluated the otoprotective effect of N-acetylcysteine before and after chemotherapy. Two independent reviewers assessed the studies and methodological quality was analyzed. The search strategy resulted in 114 articles. Following the selection process, three studies were included in the systematic review and meta-analysis. **Results:** Patients receiving N-acetylcysteine had statistically significant preservation comparing to patients in the control group at 10 and 12 KHz (mean difference [MD]: −8.16; 95% CI [−15.84, −0.48] and −6.84; 95% CI [−10.79, −2.89]), respectively. There were no statistically significant preservation at 4 and 8 KHz between experimental and control group (mean difference [MD]: −2.00; 95% CI [−14.03, 10.02] and −1.65; 95% CI [−15.88, 11.79]), respectively. There were insufficient available data to support influences in postoperative pain. **Conclusions:** N-acetylcysteine preserved only 10 and 12 KHz against sensorineural hearing loss due to ototoxicity by cisplatin. Well-designed randomized clinical trials testing the use of N-acetylcysteine by different routes of administration and at different doses are needed to justify its indication.

Phonological development in children with otitis proneness. A longitudinal study for ages 3.6 to 5.6 years

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Objective: Children with hearing loss constitute a high-risk group for delayed language and speech development. One type of hearing loss, which occurs mainly in the early childhood years, is a conductive hearing loss, caused by fluid in the middle ear (secretory otitis media). Secretory otitis media is a consequence of an upper respiratory tract infection or an acute ear infection (acute otitis media). Acute otitis media is a common childhood disease that affects almost 80% of all children at some time before the age of five. Some children experience recurrent episodes of acute otitis media. If the child has three or more episodes of acute otitis media during a six-month period, the child is said to be prone to otitis media. Thus, during a number of episodes of affected hearing ability, fluctuating and degraded acoustic signals are presented to the cochlea, limiting children's ability to discriminate, store and reproduce appropriate acoustic contrasts between speech sounds. This longitudinal study focuses on the phonological development in terms of the emerging phonological system (word- and syllable-shapes, phoneme inventories), the developmental phonological processes and phonological awareness, in Swedish children with otitis-proneness. **Material and methods:** A total number of 43 children (25 prone to otitis media, and 21 controls) were included in the study. The children's phonological development was longitudinally investigated at ages 3.6, 4.6 and 5.6 years. Speech samples, containing a maximum of 103 words for each child, were elicited by standardized picture naming tasks at the age of 3.6 and 4.6 years. At the age of 5.6 years, results concerning phonological awareness, were collected. **Results:** The results indicate no significant group differences for either phonological production or phonological awareness at the age 3.6, 4.6 or 5.6. The results from a longitudinal aspect, between 3.6 to 4.6 years, indicate some differences between the groups regarding phonological production, for example, the production of certain speech sounds and the use of certain

simplification processes. **Conclusions:** The overall findings suggests that otitis proneness before the age of 2.6 years is not an indicator for group differences in phonological development at the age of 3.6, 4.6 and 5.6 years. However, there is considerable distribution of the result, which indicates that there are individual children who do not follow the typical linguistic development.

Pilot hearing screening in school-age children from different countries in Africa

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Objectives: Hearing screening have an extremely important preventive task, being the primary means of secondary prevention. They allow for an early detection of hearing disorders, thus enabling treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. Hearing-impaired children often experience delayed development of speech, language and cognitive skills, which may result in slow learning and difficulty progressing in school. For many years the Institute of Physiology and Pathology of Hearing has undertaken a variety of initiatives in countries across continents, which include screening for hearing. The primary goal of the program is early detection of hearing impairment, especially in children who start school and at raising awareness among parents and the school environment about hearing problems. These efforts are aimed at improving the state of medicine abroad, especially in African countries, enabling access to health care and promoting healthy lifestyle. **Material:** Hearing screening was performed in group of 608 children aged from 6 to 12 years. Hearing tests were performed in four African countries: Camerun – 260 children, Nigeria – 196 children, Rwanda – 183 children, Tanzania – 199 students, Congo – 210 children, Senegal – 200 children, Ghana 170 children and Ivory Coast – 130 children. **Methods:** Screening was performed using the Sensory Organs Platform; based on an audiometric hearing threshold measurement procedure. A modern platform developed by the Institute of Sensory Organs is essential for the affordable and universal study of a large population of children. The threshold values for air conduction were determined in the frequency range of 0.5–8 kHz. The abnormal test result was the threshold value for air conduction of 25 dB HL and more for at least one frequency in at least one ear. In addition, in some countries, the study protocol was extended to include videootoscopy. **Results:** Positive hearing screening result was found in 27.9% of the examined children. In addition, there was a large number of unilateral hearing losses. Studies have shown that the scale of hearing loss among school-age children is significant in all countries participating in the program. Analyzes of videootoscopy results showed excessive earwax, funchal change, middle ear infections, of which almost half of them had this problem on both sides. **Conclusions:** Pilot hearing screening has shown that the organizational model of screening developed in Poland and the methods, devices and information systems used in the studies can be successfully implemented not only in European countries, but also in African countries. It should be emphasized that hearing screening performed outside of Poland was the first hearing screening test conducted in schools in the surveyed countries. The results confirm the high incidence of hearing problems in school children. Based on the results, it is strongly recommended to implement hearing screening in the countries concerned as a routine procedure in medical care.

Possibilities of triphasic pulse stimulation in patients with cochlear implants

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Objectives: Possibilities of triphasic pulse patterns for programming cochlear implant are presented. We examined patients with facial nerve stimulation (FNS) during postoperative period. We hypothesized that triphasic stimulation has less charge penetration into the tissues and achieve greater stimulation levels that define the dynamic range of sound perception compared to biphasic stimulation. **Material:** The analysis of 21 patients with Med-El CI system (Innsbruck, Austria), aged from 3 to 12 years (Me=6±1.98), with FNS (contraction of 1 or more facial muscles) was carried out. The CI system installed by all the subjects made it possible to choose the type of stimulation by biphasic or triphasic electrical impulses. The age of cochlear implantation surgery ranged from 6 to 75 months (Me=10±16.34). All patients have complete insertion of the electrode array into the cochlea, and all the electrodes were activated. Electrically evoked compound action potential (ECAP) was registered on each channel of the system. All patients underwent regular courses of speech rehabilitation. The criteria for exclusion from the study were: the presence of a combined neurological pathology, and congenital anomalies of the development of the cochlea. **Methods:** Initially, all patients were fitted with biphasic pulse stimulation. In all cases FNS signs were manifested. The duration of using the CI system with this type of stimulation ranged from 1 to 112 months (Me=36±21.02). Initially, the patient's FNS-induced discomforts were fitted by reducing MCL levels in combination with microphone gain correction. During speech testing the results of the auditory perception in all cases were unsatisfactory. Subsequently, all patients underwent a paradigm shift into triphasic stimulation with maximal comfort levels elevation. **Results:** After 48 hours of using triphasic pulse patterns, all patients have better results of speech intelligibility. Evaluation of whispered speech, conducted 48 hours after the change of the stimulation paradigm also showed a significant improvement of the results in most observations. We studied the values of the ECAP thresholds comparing with maximum comfort levels (MCL) for biphasic pulse patterns, in the initial period with the values of MCL at the current time. Analysis of the data showed an increase in MCL on all channels of the electrode array when using stimulation with three-phase pulses.

The use of triphasic stimulation pattern has a positive effect for rehabilitation of patients with facial nerve stimulation due to a comparatively greater dynamic range of sound perception. The relationship of MCL values for both biphasic and triphasic stimulation to ECAP thresholds was statistically significant. The increase of MCL values needed to create an effective dynamic range during triphasic stimulation can prevent the occurrence of FNS. Our study showed a positive effect of triphasic stimulation with a simultaneous increase in MCL levels on results of speech tests. Results showed significant increase of auditory perception scores after switching into triphasic stimulation pattern. **Conclusions:** The using of triphasic stimulation pattern is a promising tool for preventing facial nerve stimulation after cochlear implantation. In the case of clinical manifestations of FNS, it is recommended to use triphasic type of stimulation for programming maps in CI patients.

Preoperative significance of ipsilateral neck compression in patients with pulsatile tinnitus secondary to sigmoid sinus dehiscences and diverticula

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Purpose: Venous pulsatile tinnitus (PT) is characterized by an auditory perception of pulse-synchronous sound, suppressed by compression of the ipsilateral internal jugular vein. We sought to determine the preoperative prognostic significance of the effect of ipsilateral neck manual compression on the PT loudness and audiometric changes in patients with sigmoid sinus dehiscences (SS-Deh) and diverticula (SS-Div) by comparing postoperative improvements in ipsilateral low-frequency hearing loss (LFHL) in pure-tone audiogram (PTA) and PT symptoms. **Material and methods:** Twenty-two patients with PT originating from SS-Deh/Div were recruited. Air-conduction hearing thresholds were measured using PTA at three time points: twice preoperatively (with neutral neck position and with ipsilateral manual compression of internal jugular vein) and once at 3-months postoperatively with neutral neck position. We defined a positive neck compression effect as a threshold improvement of >10 dB HL at 250 or 500 Hz after manual neck compression. **Results:** All but two patients presented with ipsilateral LFHL in the neutral position. The average hearing threshold in the neutral position markedly improved after manual neck compression, indicating that LFHL originated from the masking effect of venous PT. All patients had subjective improvements in PT and LFHL after sigmoid sinus surgeries, confirming that LFHL resulted from the masking effect of PT. Additionally, improvement of LFHL after neck compression could be regarded as a positive prognostic indicator after surgery. **Conclusions:** Elimination of PT loudness and improvement of LFHL with manual compression over the ipsilateral neck may suggest the venous origin of the PT and predict a favorable outcome following repair of SS-Deh/SS-Div.

Preservation of hearing following cochlear implantation with Med-El cochlear system using different steroid therapy regimens

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Background: A prospective clinical study was conducted to assess different regimens of steroid therapy and preservation of hearing following cochlear implantation. **Material and methods:** Study participants were ≥18 years-of-age, with a cochlear duct length ≥27.1 mm measured by computed tomography (CT), with hearing sound levels in the range of 10–120 decibels (dB) and sound frequencies of 125–250 hertz (Hz); sound levels of 35–120 dB and frequencies of 500–1,000 Hz; sound levels of 75–120 dB and frequencies of 2,000–8,000 Hz. Study exclusion criteria included diseases with contraindications for steroid therapy or medications that increased the effects of steroids. Patients had cochlear implantation and were divided into three treatment groups: intravenous (IV) steroid therapy (standard steroid therapy): combined oral and IV steroid therapy (prolonged steroid therapy); and a control group (cochlear implantation without steroid therapy). Hearing preservation was established by pure tone audiometry based on the pre-operative and postoperative average hearing thresholds according to the formula developed by the HEARRING Network. **Results:** There were 36 patients included in the study. In all cases, the cochlear implant electrode was inserted via the round window approach with a straight electrode length of 28 mm. Patients with combined oral and IV steroid therapy (prolonged steroid therapy) had better results when compared with patients with intravenous (IV) steroid therapy (standard steroid therapy) and the control group. **Conclusions:** Prolonged steroid therapy using combined oral and IV steroids stabilized hearing thresholds and preserved hearing in adult patients following cochlear implantation.

Prevalence and clinical aspects of hearing loss among the South Korean adolescents: data from a population-based study

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Objectives: Slight/mild hearing loss is detrimental to communication and academic achievements. This study aimed to describe the prevalence of hearing loss, and to investigate

the factors related to noise-induced hearing loss among South Korean adolescent. **Methods:** As a population-based retrospective study, 1845 South Korean adolescents aged from 12 to 19 years were analyzed using the data from Korea National Health and Nutrition Examination Survey V (KNHANES V, 2010–2012). The prevalence of hearing loss according to the side, severity, and frequency was calculated. For assessing the noise-induced hearing loss in adolescent, the prevalence of hearing loss only in high-frequency (onlyHFHL, defined as 1) thresholds at 0.5 and 1 kHz of ≤15 dB HL, and 2) maximal thresholds at 3, 4, or 6 kHz ≥15 dB HL higher than the highest threshold for 0.5 and 1 kHz) was analyzed. Moreover, the relevance of onlyHFHL in context of sociodemographic factors and noise exposure history was evaluated. **Results:** The prevalence of unilateral and bilateral hearing loss based on the average of six frequencies (0.5, 1, 2, 3, 4, and 6 kHz) in South Korean adolescents were 8.56% and 1.03%, respectively, and most cases were hearing loss with slight/mild degree. The prevalence of unilateral and bilateral onlyHFHL were 32.74% and 5.53%, respectively. Factors found to be associated with onlyHFHL were sex (female) and household income (high). **Conclusions:** According to this population-based study, the prevalence of slight/mild hearing loss and onlyHFHL in the South Korean adolescents were considerably high. With knowledge of the factors related with onlyHFHL, paying more attention to slight/mild hearing loss will be helpful in preventing hearing loss in adolescents.

Prevalence of hearing loss among Polish school-age children from rural areas – results of hearing screening program in the sample of 67 416 children

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Objectives: Hearing loss in children is a relevant health issue, both for its prevalence and for its physical, emotional and social consequences. Our aim was to estimate the national prevalence of hearing loss in children from rural areas in Poland. **Material:** The study was conducted in the general, pediatric, nonclinical population of school-age children from rural areas in Poland. It was a population-based, epidemiological study. The participants were 67 416 children (32 630 girls and 34 786 boys) aged from 6 to 13 years old (*M*=8.65; *SD*=2.54). **Methods:** Pure-tone air-conduction hearing threshold were obtained at 0.5–8 kHz. Hearing loss was defined as a pure-tone average higher than 20 dB in one or both ears in at least one of the following pure-tone average: four-frequency pure-tone average (FFPTA), high-frequency pure-tone average (HFPTA) and low-frequency pure-tone average (LFPTA). **Results:** The rate of positive results of hearing screening was 16.4% and it was significantly higher in younger children than in older children. Mild hearing loss was more frequently than moderate or worse hearing loss. The children more often experienced unilateral than bilateral hearing loss. **Conclusions:** This study reveals that hearing problems are common in this population, especially among younger children. It shows a strong need for systematic monitoring of hearing status among children and increasing awareness of parents and educators of the significance of hearing loss, including unilateral and mild hearing loss. Further studies conducted among children in urban areas are needed to compare the prevalence of hearing loss in children from various environments.

Psychomotor development of children with bilateral profound sensorineural hearing loss using cochlear implant for at least 2 years

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Objectives: Due to the profound bilateral sensorineural hearing impairment, children with cochlear implant (CI) may experience delayed or discordant psychomotor development. The aim of the study was to assess the psychomotor development of these children after 2 to 3 years from the time of acquiring a CI. **Material:** 24 children with bilateral profound sensorineural hearing loss aged 36 to 52 months who received CI between 8 and 30 months of age participated in the study. **Methods:** Psychomotor Development Assessment Cards (KORP) were used in the study, which are a tool providing the assessment of psychomotor development in the areas of: motor, fine motor and lateralization, visual perception and visual-motor coordination, communication and speech, emotions and social relations, behavioral functions and pre-school or school skills (depending on the child's age). The testing using KORP was carried out between 23 and 33 months after CI activation. **Results:** Approximately 75% of the children from the study group had the level of development in the field of motor sphere and fine motor and lateralization similar when compared to a group of hearing peers from the normative group. In the field of visual perception and eye-hand coordination it was around 70%. Half of the surveyed group of children showed a low level of functioning in the sphere of communication and speech, and about 60% of the diagnosed children achieved a low level in the field of emotional and social development, behavioral functions as well as knowledge and learning skills. **Conclusions:** The obtained results indicated that deaf children who are CI users show discordant development. Developmental delays include not only the sphere of speech and communication development, but also the sphere of socio-emotional development, behavioral functions and the acquired knowledge. These children require additional support through the implementation of specialized classes focused not only on the development of language competences, but also including emotional and social functioning and raising pre-school competences.

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Pulsatile tinnitus due to dural arterio-venous fistula

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Introduction: Pulsatile tinnitus is perceived as a rhythmic pulsing and can be experienced as a thumping or whooshing

sound. About 3% of tinnitus patients experience this type of tinnitus. **Case report I:** A 28-year-old woman visited a tertiary referral center with pulsatile tinnitus of left ear for 1week. The audiology test and physical examination were no significant findings. On temporal bone MRI including angiography, she was found dural arteriovenous fistula (dAVF) in the left transverse sinus. She transferred to neurosurgery for performing embolization of dAVF. After surgery, her symptom was completely disappeared. **Case report ll:** A 35-year-old man with pulsatile tinnitus of right ear for 3 weeks visited the outpatient department. The physical examination, audiology tests, and even temporal bone CT were no significant findings. On temporal bone MRI including angiography, he was found dural arteriovenous fistula (dAVF) in right clivus and jugular foramen. After explaining the situation to the patient, he was transferred to neurosurgery for surgical intervention. **Discussion:** In these cases, two types of dAVF were identified as the cause of pulsatile tinnitus. We reported rare vascular tinnitus of two cases with literature review.

Quality of life after cochlear implantation

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Introduction: Cochlear implantation is the standard procedure for severe bilateral sensory hearing loss or severe deafness. The aim of the study was to determine how implantation influences the quality of life of patients in the Department of Laryngology, SPSKM in Katowice. **Material and methods:** At the time of the study, our database included 100 adult patients with a cochlear implant (Cochlear Ltd.). Each of them is implanted with one of the following implants: CI24R (CA), CI24R (ST), CI24RE (CA), CI24M, CI512, CI522 or CI532. A letter was sent to all patients in the database with a questionnaire regarding their quality of life. The questionnaire was developed by the clinic team and contained questions about, among others. demographic data, professional activity, social contacts, rehabilitation, and self-perception. The questionnaire was divided into two parts: the first one contained closed questions, the second one contained open questions in which the patient was asked, among others. about his feelings, opinions and changes that took place in his life after implantation. The questionnaires that were sent back to the clinic were analyzed for the so-called general data, and patient activity. **Results:** Background information: Out of the 100 questionnaires sent out, we received back 65: 45 from women and 20 from men. The mean age was 60.5 years (min. 27, max. 81). Patients have been using cochlear implants for an average of 6.1 years (min. 1.5 months, max. 15 years). 65% of patients use their CPU for more than 12 hours a day. 23% of patients are users of the Nucleus Freedom processor, 11% are users of the Nucleus 5 processor, 55% are users of the Nucleus 6 processor, and 11% of the Nucleus 7. Of all patients who responded to the questionnaire, only 10% use wireless accessories (5% are users the MiniMic wireless mini-microphone, and another 5% use the PhoneClip phone clip). Patient Activity: The results showed a difference in patient activity before and after cochlear implantation. 71% of patients emphasize that their contact with family members is better after implantation than before. 76% of respondents declare better understanding of speech and better contact with other people after implantation. 72% of patients indicate that their self-confidence is significantly greater after surgery. **Conclusions:** Cochlear implantation helps patients improve their quality of life, increase self-confidence, and is recommended by patients themselves for all eligible patients.

Recurrent respiratory papilloma of the larynx – a case study

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Recurrent respiratory papillomatosis (RRP) is the most common benign neoplasm of the larynx. It is of viral origin that is caused by human papillomavirus types 6, 11, 16 and 18 and is associated with exophytic lesions of the airway. We present a 38-years old voice professional patient with extensive papilloma of the larynx. He has presented hoarseness for 1 year, without stridor or dyspnea. Between December 2017 and June 2019 he underwent 4 surgeries with excision of papilloma (without type examination). We discovered intraoperatively very intensive, massive exophytic lesions proliferating in supraglottic space restricting respiratory area. Vocal folds were covered with papilloma in anterior part and lesion was going into subglottic anterior area. Diagnostics test discovered 6 and 11 HPV types. The patient was included into therapeutic program with local intralesional Cidofovir injection. Before that the patient was vaccinated with Gardasil-4. We performed 9 surgeries under general anaesthesia with removal of papilloma using CO2 laser and with Cidofovir injection at the same time. The amount of Cidofovir injected each time of operation was 26.25 mg (7.5 mg/ml). The successive surgeries were performed every 2 months. Laryngostroboscopic examination before 1 injection discovered extensive exophytic lesions proliferating in supraglottic space restricting respiratory area but without stridor and dyspnea. Vocal folds were invisible, covered with supraglottal papilloma. Voice evaluation tests showed: GRBAS-G3R3B2A3S3; MDVP – all parameters were very disturbed; VHI – 94 (total score). After 9 injection sessions we observed gradual decrease of lesions amount. The last examination showed no recurrence of papilloma. We observed improvement in voice quality (G1R2B0A0S1), MDVP (decreasing of parameters' values), self-assessment with VHI-30 (0 total score).

Rehabilitation of patients with a cochlear implant using artificial intelligence algorithms

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Background: Artificial Intelligence Systems (AIS) are software systems that mimic human thinking. AIS are currently used in many tasks. These are financial transactions, loan approval, assistance in making decisions on the exchange, currency detectors in ATMs, use in search engines on the

Internet, use in mobile phones. Recently, artificial intelligence systems have been actively used in medicine. Actively use artificial intelligence systems in microscopy and microbiology for algorithms for the automatic recognition of certain structures. Neural networks and expert systems are also used to diagnose and monitor the patient's condition with meningitis and bacterial infections. Assistance in making a diagnosis according to examination, differential diagnosis of tuberculosis, analysis of data from CVP, ECG, Encephalogram, MRI, CT. We began to use artificial intelligence systems in rehabilitation after cochlear implantation. The success of cochlear implantation depends on many factors: on the selection of patients for cochlear implantation, successful surgery, and postoperative rehabilitation of the patient. During the rehabilitation of patients, it is very important to properly configure the auditory processor of the cochlear implant. In complex cases, subjective tuning methods cannot be used. Then objective research methods are used to configure speech processors. The most common method is to register an electrically triggered stapedial reflex. But in some cases, this study is impossible to perform. Then the telemetry method of the nerve response is used, which has less accuracy for tuning processors. At the Institute of Nasal Throat Ear and Speech, together with the Krasnoyarsk Medical University, a neural network was developed that allows the processing of telemetry data of the nerve response. Based on the results of the examination, synthesize tuning cards for the auditory processors of the cochlear implant with much greater accuracy. **Results:** We examined 90 patients. The examined patients were divided into two groups. The first group (85% of patients) was used to train the neural network. The second group (15% of patients) in the training sample was not taken into account and formed a comparison group to assess the effectiveness of the neural network after training. More than 80 neural networks were trained. As a result of processing, we selected the network that turned out to be optimal according to statistical indications. It turned out that for the network to work, it is enough to use only three significant parameters. The network structure consisted of three input neurons, three hidden neurons and one output neuron. The share of the correct forecast for the operation of this network was 99.2%. **Conclusions:** Using an expert system can significantly simplify the configuration of the speech processor in adult patients, avoid mistakes in young professionals who are just starting to set up cochlear implant systems. The use of an expert system can improve the quality of the processor fittings and reduce the rehabilitation time.

Rehabilitation of patients with auditory neuropathy and a cochlear implant

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Introduction: At the St. Petersburg Institute of Ear, Throat, Nose and Speech, more than 5,000 patients with a cochlear implant (CI) are observed. Great experience has been gained not only in surgical interventions, but also in the rehabilitation measures of implanted patients. Special groups of patients deserve special attention – elderly patients, patients with various abnormalities of the middle and inner ear, patients who have undergone meningitis, patients with auditory neuropathy. Auditory neuropathy (ANSD) is a syndrome characterized by impaired speech intelligibility. Thresholds of hearing, while this can vary from 1 to 4 degrees. Diagnostic criteria for ANSD are the absence of registration of thresholds of VSR, the presence of the microphone potential of the cochlea, and in some cases the registration of otoacoustic emission. **Objective:** The purpose of the study was to identify the features of rehabilitation measures in patients with auditory neuropathy. **Material and methods:** The study involved 15 patients with heart failure from 3 to 9 years. All of them underwent CI. Within 2 years, the dynamics of the tuning cards of the speech processor, auditory testing were carried out. Results. All patients regularly used CI. All showed stable responses to tonal signals of 30–35 dB. When evaluating training cards, 27% of patients had high MSL thresholds, used the CIS strategy, and a low stimulation frequency. 73% of patients showed progress in speech intelligibility, and 27% showed little progress. 60% of patients reached level 5 of speech intelligibility (intelligibility of simple sentences) in 24 months, 7% – level 6 (understanding of speech of family members) in 24 months. **Conclusions:** In all patients with ANSD, steady responses to tonal signals of 30–35 dB were observed. The group of patients with heart failure is heterogeneous, which may be related to the topography of the disorder (pre-/postsynaptic disorders), the rehabilitation periods for this group of patients should be increased. In the development of auditory reactions, an integrated approach is important – regular settings of the KI processor, classes with a sign teacher, speech therapist and independently in the family.

Relationship between atypical Clinical Test of Sensory Interaction in Balance (CTSIB) test results and self-report anxiety in patients seeking help from a Balance clinic

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Objectives: It has been suggested that anxiety could be an influencing factor causing patients to display atypical results on the modified Clinical Test of Sensory Interaction in Balance (CTSIB). Atypical results are indicated when a patient is able to complete the most difficult condition (standing on foam, eyes closed) within the normal range but they show abnormalities on any of the other 3 easier conditions (condition 1: firm surface, eyes open; condition 2: firm surface, eyes closed; condition 3: foam surface, eyes open). The CTSIB is recorded as a pass or fail for each condition based on the computer analysis of the sway data, the patient's age, gender and height. The aim of this study is to investigate the correlation between CTSIB results and the degree of anxiety reported by the patient. **Material:** Balance tests were the CTSIB alongside cVEMPs, oVEMPs, ocular motor testing and caloric testing (done via video-nystagmography). Questionnaires administered were: Visual Analogue Scale (VAS) of anxiety and Generalized Anxiety Disorder (GAD-7). The VAS scale was asking the patients to rate from 0 to 10 how anxious they were feeling about their appointment (0 being not anxious at all and 10 being the most anxious they have ever felt). The purpose of this scale was to assess the degree of anxiety that the patient was feeling on the day of the appointment. The GAD-7 is a validated trait anxiety questionnaire, the purpose

of which was to assess the patient's general level of anxiety in their daily life. **Methods:** This was a retrospective study. Data were gathered from records of 37 consecutive patients who sought help for vestibular assessment from an audiology clinic in the UK and completed VAS and GAD-7. The average age of the patients was 56 years (standard deviation, *SD*=14.4 years, ranged between 24 and 82 years). Sixty two percent (23/37) were female. **Results:** Twenty seven percent of patients (10/37) had abnormal anxiety score as measured via GAD-7. The scores on GAD-7 were moderately correlated with the score on VAS of anxiety (correlation coefficient r=0.35, p=0.044). On the CTSIB 11.1% of patients failed condition 1, 13.8% failed condition 2, 28.5% failed condition 3 and 37.1% failed condition 4. About 19.5% of patients had atypical result. Mann-Whitney test showed no statically significant difference in measures of anxiety between patients with typical and atypical balance test results. **Conclusions:** Our results show that there does not appear to be a significant correlation between anxiety and atypical CTSIB results. Therefore the CTSIB test should not be used in clinic as a significant indicator for onward psychological management. Currently atypical CTSIB results are written in our clinic reports as due to "volitional or non-volitional exaggerated responses". This appears to still be an appropriate summation of the result as it is not clear from the CTSIB alone whether atypical results could be incidental or indicative of a non-organic component. At present it appears that the correct process is to leave up to the clinician's judgement, from the patient history and interaction, to assess whether there may be a non-organic element indicated and/or whether there is need for psychological support.

Repeatability of otoacoustic emissions' suppression in young adults – preliminary results

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Objectives: The aim of the current study was to evaluate the repeatability of otoacoustic emissions' suppression in adults with normal hearing. **Material:** Into the study we included young adults who voluntarily agreed to participate. The main eligibility criteria were: normal hearing in both ears (based on the interview and screening pure-tone audiometry) and participant's age being 18 to 30 years old. There were similar number of male and female participants in the study population. The mean age of the participants was *M*=20.9, *SD*=2.22. **Methods:** After signing an informed consent, participants underwent a pure-tone screening audiometry to confirm their hearing status. Next, the repeatability of OAE's suppression was conducted according to the protocol consisting of two subsequent measurements of otoacoustic emission suppression with a probe in the ear. Additionally to OAE suppression, the presence of spontaneous OAE was measured. All measurements were conducted in the quiet study room. **Results:** No differences were observed between two measurements in terms of signal to noise ratio and suppression, even when controlling for the SOAE occurrence. Interestingly, significant differences regarding the signal to noise ratio were observed between subjects with SOAE and without SOAE. Participants with SOAE had about two times bigger signal to noise ratio than participants without SOAE. However, no such differences were observed regarding the OAE suppression value. Conclusion. Based on the current findings we conclude that OAE suppression is repetitive, which proves in favor of further consideration of the use of this method in clinical practice.

Resiliency in people experiencing tinnitus

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Introduction: Tinnitus is an ailment which due to the frequency of occurrence and in most cases of chronic nature is a social problem. Coping with a chronic ailment is a long-term process affected by the personality characteristics of an individual. Resilience is one of such personal resource and can be explained as adaptive flexibility in temporary adapting to the requirements of the environment level of impulse control. The aim of the study was to determine whether these human potential affects the perceived tinnitus annoyance. **Material and methods:** The study involved 176 people diagnosed with chronic tinnitus. The results were compiled using: Resiliency Assessment Scale (SPP-25) for measuring resiliency and Tinnitus Functional Index (TFI) evaluating the impact of tinnitus on the daily functioning of the subjects, as well as a survey designed for the study, comprising questions about sociodemographic data and tinnitus history. **Results:** The study showed a negative correlation between resilience and perceived annoyance of tinnitus. Regression analysis showed that personal competencies to cope and tolerance of negative affect as the only resilience factor are an important predictor of overall tinnitus annoyance. Reduced tinnitus annoyance can be expected among people with a high level of personal competencies to cope and a high level tolerance of negative affect. **Conclusions:** Resilience, and especially its factor – personal competencies to cope and tolerance of negative affect – is related to the perception of tinnitus annoyance. Research should be continued in order to search for other personal resources that affect the perceived tinnitus annoyance.

Results of cochlear implantation in patient with incomplete partition type 3 and cochlear ossification

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Introduction: Congenital defect of the inner ear, incomplete partition type 3, belongs to the group of rare diseases causing congenital hearing loss or deafness. A characteristic

feature of this condition is the constant appearance of gusher during surgery. **Aim:** The aim of the study was to present the surgical technique and assess hearing results obtained after cochlear implantation in a child with IP type 3, profound bilateral sensorineural hearing loss and ossified cochlea. **Material:** The described patient was a male child with congenital hearing loss. The child suffered from meningitis that resulted in complete hearing loss and ossification of the cochlea in CT scans. The patient was qualified for cochlear implantation. There were some problems during the operation that allowed the insertion of only 5–6 active electrode contacts. We did not observe gusher during operation of this patient. **Results:** Initially, the results of cochlear implantation in this patient were very limited. After two years of rehabilitation we observed significant improvement, and now the patient has noticeable and satisfactory results. **Conclusions:** Even in cases with very complicated anatomy, congenital malformation of the inner ear and ossified cochlea, there is possibility to improve hearing using cochlear implants. The results are worse than in patients without structural defects of the cochlea, but in the cases like this the alternatives are very limited if any.

Results of hearing screening in nursery school children aged 5–6 years

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Objectives: The aim of the current study was to evaluate the hearing of nursery school children using self-constructed survey and a well-established screening tool: Sensory Examination Platform (SEP). **Material:** Nursery children attending a single kindergarten in Warsaw, Poland, were included in the analysis. The eligibility criteria were child's age ≥5 years old, child being mature enough to undergo a pure-tone audiometry using SEP and being healthy on the examination day. **Methods:** The audiometric measurement were conducted in a separate room in the quiet part of the kindergarten. Self-constructed survey consisted of questions regarding the existence of hearing problems in a child, the occurrence of child's asking for repetitions of questions or information, the existence of tinnitus, the existence of listening to loud music by a child, previous history of otological treatment and complaining of the child to excessive noise at nursery school. Every question had two possible answers: "yes" or "no". The survey was filled in by a parents before completing the audiometric measurement. The positive hearing screening result was established when a hearing threshold of at least 25 dB HL was observed for at least one frequency (250–4000 Hz) in at least one ear. **Results:** Into the study we included 122 children aged 5 to 6 years. There were 48% of girls and 52% of boys. Positive hearing screening results was observed in 24% of children. There is a significant difference between the percentage of unilateral hearing loss (72%) and the percentage of bilateral hearing loss (28%). Based on the self-report survey, 63.6% of children, whom parents answred "yes" for the question regarding the existence of hearing problems in a child, have positive hearing screening results. Also 60% of children, whom parents reported that their child listens to the loud music, have their results incorrect. **Conclusions:** Hearing impairment seems to be a frequent problem among nursery school children. The results of this study indicate that hearing screening in nursery schools could enable even earlier diagnosis of hearing impairments in children. It is especially important considering observed lack of awareness about the hearing loss existence in nursery children among parents.

Results of pilot hearing screening in schoolchildren from selected Asian countries

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Objectives: As a result of the European Scientific Consensus agreement, a number of pilot hearing screening programs were started by the Institute of Physiology and Pathology of Hearing in various countries, promoting hearing-loss detection and treatment of communication disorders in young school-age children. The aim of the study was to evaluate the hearing status of schoolchildren from selected Asian countries and to further raise awareness among parents, schools, and governments on the need of conducting hearing screening programs. **Material:** Hearing screening was performed in a group of 1027 children aged from 6 to 12 years, in four Asian countries: Armenia, Russia, Kyrgyzstan and Azerbaijan. The study was carried out with the use of the Sensory Examination Platform. The threshold values for air conduction were determined in the frequency range of 0.5–8 kHz. The eligibility criteria were: good cooperation with the child, low noise level during the examination and the ability to measure hearing thresholds for all evaluated frequencies. **Methods:** The positive hearing screening result was established when a hearing threshold of at least 25dB HL (hearing loss) was observed for at least one frequency in at least one ear. All statistical analyses were conducted using IBM SPSS v. 24. **Results:** Based on the eligibility criteria, the results of 876 children were found suitable for statistical analyses. Among them, 35% were from Kyrgyzstan, 31.6% from Armenia, 22.6% from Azerbaijan and 10.7% from Russia. In 74.3% of children normal hearing was observed. Unilateral hearing loss was observed 14.4% of children and bilateral in 11.3%. Hearing loss was the most prevalent in Azerbaijan – 47% of children had positive hearing screening results. The lowest occurrence of hearing loss was observed in Russia (14.9%). The frequency of hearing loss in the evaluated study group turned out to be higher than that observed so far in the countries of Europe, the United States or Canada. **Conclusions:** The high incidence of hearing loss in children from selected Asian countries indicates the need of conducting hearing screening programs in this

part of the world, which would allow for earlier diagnosis of hearing problems a child and enhance the possibility of introducing a proper diagnostic and therapeutic approach leading to the best results.

Revision ossicular chain reconstruction – hearing results

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Objective of the study was to evaluate improvement in hearing outcomes following revision PORP and TORP Titannium prosthesis operations. Retrospective review of patients operated between 2012 and 2016 was performed. Pre- and postoperative audiograms were used to compare the changes in pure-tone averages (PTA), and air-bone gaps following reconstructive surgeries. Revision ossicular chain reconstruction is an acceptable method to improve residual conductive or mixed hearing loss.

Role of microRNA-375-3p-mediated regulation in tinnitus development

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Objectives: Changes in the dorsal cochlear nucleus (DCN) following exposure to noise play an important role in the development of tinnitus. As the development of several diseases is known to be associated with microRNAs (miRNAs/miRs), the aim of the present study was to identify the miRNAs that may be implicated in pathogenic changes in the DCN, resulting in tinnitus. **Material:** A total of 102 rats were used in the present study. All rats were exposed to 6–8 kHz narrow-band noise at 110 dB sound pressure level (SPL) for 2 h, with the left ear plugged and sutured. This noise-exposure protocol was developed in our previous study and confirmed to induce a TTS on the right side only. To detect the hearing changes, the ABR was recorded on day 1, and at 1 and 3 weeks post-noise exposure, whereas GPIAS responses were recorded at 1 and 3 weeks following exposure. The development of tinnitus was determined based on the recorded GPIAS responses. **Methods:** The study consisted of four stages, including identification of candidate miRNAs involved in tinnitus development using miRNA microarray analysis, validation of miRNA expression using reverse transcription-quantitative PcR (RT-qPCR), evaluation of the effects of candidate miRNA overexpression on tinnitus development through injection of a candidate miRNA mimic or mimic negative control, and target prediction of candidate miRNAs using mRNA microarray analysis and western blotting. **Results:** The miRNA microarray and RT-qPcR analyses revealed that miR-375-3p expression was significantly reduced in the tinnitus group compared with that in the nontinnitus group. Additionally, miR-375-3p overexpression via injection of miR-375-3p mimic reduced the proportion of animals with persistent tinnitus. Based on mRNA microarray and western blot analyses, connective tissue growth factor (CTGF) was identified as a potential target for miR-375-3p. Thus, it was inferred that CTGF downregulation by miR-375-3p may weaken with the decrease in miRNA expression, and the increased proapoptotic activity of CTGF may result in more severe neuronal damage, contributing to tinnitus development. **Conclusions:** These findings are expected to contribute significantly to the development of a novel therapeutic approach to tinnitus, thereby bringing about a significant breakthrough in the treatment of this potentially debilitating condition.

School readiness and academic achievement of children who are deaf and hard of hearing in South Africa

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Objective: Evidence across the world highlights persistent inequity in enrolment, attendance, learning outcomes, and academic achievement based on gender, poverty, geographical location, ethnicity, health status and disability. Consequently, South African policies and the national development plan recognize the state's responsibility for children's development by emphasizing the need for an effective and integrated system to ensure that essential early childhood development services are accessible to all, especially for those children whose development is most at risk, such as those of children who are deaf of hard of hearing (DHH). Children who are DHH may be at risk of not achieving the necessary school readiness due to the link between hearing loss and academic achievement. However, the widely reported positive influence of EHDI programs on future academic success for children who are DHH highlights the need for laying a solid foundation in order to ensure adequate development and school readiness for children who are DHH in the South African context. The aim of this study was to describe the school readiness and academic achievement of children who are DHH who were enrolled in EHDI preschools in Gauteng, South Africa. **Methods:** The researchers conducted retrospective record reviews of EHDI preschool records and surveyed Grade 3 teachers for eight children who are DHH and graduated from EHDI preschools. The teachers completed a newly-constructed self-administered questionnaire. Data were analyzed using descriptive statistics, namely measures of dispersion and measures of central tendency. **Results:** Three of the eight children obtained age-appropriate school readiness results and were subsequently enrolled in mainstream schools. Five of the eight children did not demonstrate age-appropriate school readiness and were subsequently enrolled in remedial and Learners with Special Education Needs (LSEN) schools. All the children successfully

completed the foundation phase of formal schooling. Six of the children completed the foundation phase in the prescribed three years, while two of the children completed the foundation phase in four years due to recommended changes in the type of school of enrollment. **Conclusions:** Through EHDI programs, children who are DHH are afforded the opportunity to experience the positive outcomes of these programs as demonstrated by the school readiness, schooling profile and academic achievement found in this study.

Self-help interventions chosen by subjects with chronic tinnitus – a retrospective study of clinical patients

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Objective: Self-help (without specialist support) can play an important role in tinnitus therapy. The purpose of this study was to investigate what fraction of subjects with tinnitus use self-help, what techniques are most commonly used to reduce tinnitus severity, and what distinguishes patients that use self-help from others. **Material and methods:** Design: retrospective, observational study. Study sample: Adult patients admitted to our hospital clinic (460 participants) aged 19–83 years and,reporting chronic tinnitus. The survey concerned therapy attempts prior to the clinic visit as well as self-help techniques chosen freely by the patient to reduce tinnitus severity. **Results:** Data showed that 40.9% of the respondents chose some action themselves to reduce their tinnitus severity. Among the reported self-help techniques, acoustic stimulation was the most popular. In addition, patients chose distraction attention, relaxation, meditation, yoga, and physical activity. The likelihood of undertaking self-help increases with better education and higher tinnitus severity. **Conclusions:** Knowledge about patients' preferences of forms of self-help may help the health practitioner suggest a more suitable form of therapy. Due to the great interest in using sound therapy in tinnitus it would be worthwhile looking at new forms of this therapy, for example increasingly popular mobile applications.

Sense Examination Capsule – a device of the future

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Screening programs are an important element of public health. Early detection of disorders and treatment significantly reduces the cost of health care. The increasingly aging society forces the creation and development of new methods and devices for screening. These tools must allow effective access to the patient. Currently, there is no such system of devices in the world, thanks to which it is possible to perform a study of the most important sensory and speech organs in one place and a short time. To diagnose subsequent organs, patients must visit several centers – this means many visits and often long months of expectations for consultations. For many, diagnostics are so burdensome that they give up research and treatment. In response to the demand, an innovative diagnostic and rehabilitation capsule has been created that can be installed in various field centers. The Sense Examination Capsule is the world's first integrated device for the study of the human senses. The capsule allows you to test your sense of smell, taste, sight, hearing and balance. Her main task is: (1) early detection of sensory disorder, (2) early capture of prognostic factors predicting the development of neurodegenerative diseases, (3) early implementation of mental and movement training, (4) dissemination and improvement of access to preventive examinations of people with multiple sense organs disorders, as well as their rehabilitation. During the conference, the possibilities of using the Sense Examination Capsule will be presented. The solutions and diagnostic tests used as well as the individual and social benefits of investing in such devices will be discussed in detail.

Sequencing of clinical exome identifies multilocus genomic variation related to three known hearing loss syndromes in one patient

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Introduction: Genetically determined hearing loss may occur in an isolated or syndromic form. There is a wide range of syndromes for which hearing loss represents one of the characteristic features, such as Stickler and Alport syndrome. One of the most frequently observed inner ear malformation identified during a radiological workup of hearing loss patients is large vestibular aqueduct syndrome (LVAS). **Objective:** The aim of the study was to identify genetic variants that cause hearing loss in an adult female patient who was diagnosed with bilateral hearing loss, LVAS, high myopia, osteoarthritis and microhematuria. **Material and methods:** Next-generation sequencing of clinical exome was performed using the TruSight One sequencing kit (Illumina) on DNA isolated from the proband's blood sample. Analysis of the results focused on variants located in the genes related to hearing loss. To test for the presence of a haplotype located in the 5' region of the SLC26A4 gene (CEVA) in the proband and to confirm the presence and segregation of the identified pathogenic variants in the proband and her family members Sanger sequencing was performed. **Results:** Next-generation sequencing revealed the presence of a known

COL2A1 pathogenic variant (NM_001844.4: c.1833+1G>A) causative for Stickler syndrome and one pathogenic change in COL4A5 (NM_000495.4: p.Gly624Asp/c.1871G>A) causative for Alport syndrome. In SLC26A4 (NM_000441.1: p.Leu597Ser/c.1790T>C) only one known pathogenic variant was found and the CEVA haplotype was not detected. **Conclusions:** Simultaneous testing of many genes using next-generation sequencing followed by family analysis identified a de novo pathogenic variant in the COL2A1 gene and after clinical reanalysis, the patient was diagnosed with Stickler syndrome, which is inherited in an autosomal dominant manner. The patient was found to be a carrier of a COL4A5 variant for the X-linked Alport syndrome, which explains the occurrence of microhematuria and may account for some degree of her hearing loss. The cause of LVAS still remains unknown as only one SLC26A4 pathogenic variant and no CEVA haplotype were found, and the disorder is inherited in an autosomal recessive manner. Our study identifies the presence of three rare known hearing loss syndromes in one patient and emphasizes the important role of genetic testing in guiding clinical diagnosis.

Sound localization and patients' satisfaction in SSD-CI users

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Introduction: Since 2011 single sided deafness (SSD) is an indication for Cochlear Implantation (CI). Previous conventional, non-invasive treatment options, such as CROS hearing, never rehabilitated the affected, deaf ear. Those methods only tried to compensate the disabilities in difficult environments transferring sound to the normal hearing ear (NH). A CI works differently, by electrically stimulating the deaf ear, thus providing bilateral hearing. Most important after CI is the rehabilitation. In bilateral hearing loss, the exercises can be done easily by presenting the audio files via loudspeaker. In SSD, this setting is not useful because the NH compensates the speech understanding in quiet, but practise for the CI ear is necessary. Therefor a direct stimulation of the CI witch auditory accessories like a FM-cable or a neck loop is mandatory to bypass the NH and just exercise the CI side alone. The aim of this study was therefore to test SSD-CI users in different setting for hearing in noise and sound localisation abilities together with an subjective evaluation of their performance via questionnaires. **Material and methods:** All measurements were performed in the unaided SSD condition (SSD) and in the CI aided SSD condition (SSD-CI). Benefit of speech understanding in noise was tested with the adaptive OLSA (S0N0). For the sound localization test, a seven loudspeakers cemicircle setup was used. To demonstrate the individual failure a Root Mean Score Error (RMSE) and the bias was calculated. To evaluate the patients' quality of hearing and satisfaction two questionnaires were used. The first, was the "Abbreviated Profile of Hearing Aid Benefit questionnaire" called APHAB. The questionnaire is structured in four subscales: Ease of Communication (EC), Reverberation (RV), Background Noise (BN), and Aversiveness (AV). The second questionnaire used was the "Speech, Spatial and Qualities of Hearing Scale", (SSQ12). Inclusion criteria was based on manufacturers recommendation and additionally patients had to have stable hearing loss >1year), aged 18 years or older and required CI experience of at least one year. **Results:** Ten subjects (eight females and two males) with a mean age at implantation of 45.6 years were included. The mean PTA4-NH (normal hearing ear) was 11.25 dB and the mean PTA4-SSD (affected ear was) 93,875 dB. The unaided mean SNR ws at −3.35 dB and in SSD-CI aided condition −5.29 dB SNR. The difference of speech understanding in noise with the CI was 1.95 dB SNR which is an enhancement of 32.98% (p<0.05). The mean RMSE showed a significant improvement in sound localization (p<0.05). The results in the unaided condition showed that most of the signals were located on the normal hearing side. Subjects also reported that their individual quality of life has improved with the CI, which was also reflected in the questionnaire outcomes. The results of the APHAB questionnaire show that the biggest difference and improvement, is in the category BN. For all ten patients the individual, subjective assessment in situations of understanding when there is a background noise, is 28% better in the condition of SSD-CI. The overall APHAB score resulted in a significant improvement in the two different conditions (p<0.05; 41% vs 29%respectively). The overall mean SSQ12 score was 57% in unaided SSD and in SSD-CI 40% which means an improvement of 17% (p<0.05). **Conclusions:** The results for the ten SSD-CI patients showed significant improvements after Cochlear implantation in all tested categories: in speech understanding in noise with the OLSA in the condition S0N0, in sound localization with seven speakers as well as in the two different questionnairs, the APHAB and the SSQ12, (p<0.05).

Speech-in-noise perception through audio-tactile sensory substitution

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Understanding speech in background noise is challenging. Wearing face-masks, imposed by the COVID-19-pandemic, makes it even harder, by limiting access to visual speech cues. We developed an audio-tactile setup, including a sensory substitution device (SSD) that can deliver speech simultaneously through audition & as vibrations on the fingertips. We examined whether speech understanding in noise can improve through audio-tactile training. We also evaluated changes in resting-state networks following audio-tactile speech integration & learning. Twenty(20) participants with normal-hearing participated in the study. They performed three tests of repeating vocoded sentences in background noise: a)only through audition(A), b)with matching tactile vibrations (representing low-frequencies of speech, ATm) and c)with non-matching tactile vibrations(ATnm) on the two fingertips of the dominant hand, before and after short training of repeating sentences with visual feedback (<45min).The outcome measure in each test was mean Speech Reception Threshold (SRT).The data was analysed in SPSS 20 using paired t-tests. Seventeen (17) subjects

participated in a resting-state fMRI exam (10 min), both before and after training. The data was analysed in CONN toolbox 20. We found that participants improved in A from 21.46±10.68 dB to 6.71±7.96 dB [$t(19)=8.48$, $p\leq0.001$], in ATm from 14.66±8.68 dB to 1.89±6.28 dB [$t(19)=9.45$, $p<0.001$], and in ATnm from 14.60±8.96 dB to 10.44±8.62 dB [$t(19)=2.66$, $p=0$ 016] Before training the SRT values in A and in ATm [$t(19)=3.52$, $p=0.002$] and between A and ATnm [t(19)=4.54, $p<0.001$] were significantly different, whereas scores in the two audio-tactile speech tests were not different ($p=0$ 97).After training all three test scores were found statistically significantly different [A vs ATm, $t(19)=3.97$, $p=0.001$; A vs ATnm, $t(19)=3.3$, $p=0.004$; ATm vs ATnm, $t(19)=6.7$, $p<0.001$]. The rsfMRI analysis revealed increased functional connectivity between the ICA component encompassing multisensory temporo-parieto-occipital regions with the left insular cortex [peak in MNI (x,y,z)=–39–5 0], & the ICA component encompassing bilateral auditory cortices with the right occipital pole/lateral occipital cortex, for the PRE>POST comparison (FDR cluster corr at 0 05). We show that speech understanding in noise can improve through short multisensory training and generalize to both a unisensory and a multisensory test situation. The degree of improvement >10 dB indicates more than a doubling of the perceived loudness. The best score (lower SRT) after training for ATm indicates multisensory enhancement due to the inverse effectiveness rule. It seems that the training, by removing some difficulty from the auditory signal, facilitated use of the concurrent tactile inputs (participants learned to ignore the non-matching tactile stimulation).These effects might be related to the revealed changes in resting-state networks. After speech understanding has improved, we found lesser involvement of the insular cortex indicated in associative learning; as well as decreased communication between the auditory cortices and the visual system. Early visual cortex has been found involved in multisensory audio-visual speech contexts, whereas LOC has been indicated in the integration of multisensory inputs, including those delivered via touch. In general, our results show that long after the classical "critical periods" of development are over, a new pairing between a certain computation (here, speech processing) and an atypical sensory modality (here, touch) can be established & successfully trained.

Superior Canal Dehiscence (SCD) – case report

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Objectives: Vertigo, dizziness and imbalance are commonly correlated with hearing problems. We present case of patient with mixed hearing impairment and vestibular symptoms. **Material:** 36 years old woman was suffering from fluctuating hearing on her left side, dizziness after position changing and imbalance during jogging. She had plugging and tinnitus in her left ear as well as imbalance problems and unspecific vertigo in everyday activity. She was not suffering on any other medical conditions. She was not taking any medications. Betahistine was not helpful in her vestibular symptoms. **Methods:** We present audiological and otoneurological findings. Audiometry revealed mixed hearing impairment mostly on lower frequencies. Intensity of hearing impairment was fluctuating. In tympanometry there was type A in both ears but reflex from stapes muscle was also variable. In videonystagmography where was no vestibular loss of function. We present also VEMP findings, which suggested fistula in left inner ear.,,CT scans confirmed SCD on her left side. **Results:** For patients with dizziness correlated with hearing problems differential diagnosis should include: otosclerosis, Meniere's disease, inner ear malformations, SCD. **Conclusions:** In case of dizziness and fluctuating mixed type hearing loss CT of temporal bone and VEMP should be obligated to confirm SCD.

Surgical treatment of patient with one-sided bamboo nodule of the vocal fold – case study

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Objectives: Bamboo nodule is one of benign lesions of the vocal folds. In videolaryngostroboscopy it is seen as transverse cream-yellow band located typically in the middle of vocal folds resembling bamboo joint. It is described as laryngeal manifestation of autoimmune diseases. **Material:** This study describes the case od 53-year old woman who presented with 6-month history of hoarseness and ten-year history of rheumatoid arthritis (RA), currently without symptoms. **Methods:** The patient underwent otolaryngological and phoniatric examination including videolaryngostroboscopy (VLS), perceptual evaluation (GRBAS scale), acoustic analysis of voice (MDVP software) and subjective voice evaluation with questionnaire VHI-30 (Voice Handicap Index). Microsurgery was performed using a CO2 laser. **Results:** VLS revealed subepithelial white mass in ½ of the superior surface of the right vocal fold referred as "bamboo nodule". MDVP revealed significant voice disturbances in amplitude parameters. The GRBAS and VHI-30 showed mild voice disturbance. The patient was referred for direct microlaryngoscopy and microsurgery. Inspection of the vocal folds during microlaryngoscopy showed white transversal stripe originated from the vocal ligament of the right vocal fold. The mass was removed. Evaluation 3 and 12 months after surgery revealed improved quality of voice and no recurrence of the bamboo nodule. **Conclusions:** Laser microsurgery is effective method of treatment of bamboo nodule. After appearance of bamboo nodule on the vocal fold, patient should undergo specialist diagnostics of autoimmune diseases, because changes in the larynx could be the first and sometimes only symptoms.

Suspicion of delayed speech development and auditory central conductivity of the brainstem in children with autism

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Introduction: A child's speech delay can be caused by various reasons. The causes causing a delay in speech development can be in various locations ranging from speech engines

through chu and ear to the central nervous system. **Objective:** The aim of the study was to assess auditory central brainstem conduction (I–V values of auditory brainstem responses) in children with suspected delayed speech development. **Material and methods:** We examined 20 children from 2 to 8 years old – average age 4.2 years. The children were examined otoscopically, we found no abnormalities in the middle ear. We performed objective tests of hearing thresholds and topodiagnostics using auditory brainstem evoked potentials (ABR). We assessed hearing thresholds for click stimuli and a short tone with a frequency of 1000 Hz with a short stimulus rise time. The average values of hearing thresholds for a click stimulus were 7.2 dB nHL, the maximum value was 10 dBn HL, the minimum value was 5 dB nHL. Whereas for 1000 Hz average hearing thresholds were 15.4 dB nHL, maximum value – 30 dBn HL, minimum value – 10 dB nHL. **Results:** In 15 children, we found an increase in central conductivity (I–V interval) of the brainstem with an average value of 0.42 ms – maximum value 0.6 ms, minimum value 0.3 ms. The values of the I–V interval in these children ranged from 4.3 ms to 4.6 ms. We found normal values of 4.05 ms ±0.15 ms in 5 children. **Results:** The results of the study indicate an extension of central conduction and on the recommendation of performing topodiagnostic ABR tests to assess the value of the I–V (central conduction) interval of auditory brainstem responses in children with autism with suspected delayed speech development.

Talking with children metters: Technologies, parents and therapists need to be in tune

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New electronic device technologies that improve audibility for hearing impaired children such as hearing aids and cochlear implants have favored families of these children having to make choices early and often have difficulty providing sufficient language. For building a strong and effective language base. Therefore, instruments that help parents develop playful and creative activities in their daily routine seem to be an important tool for parents to create more opportunities to stimulate dialogue between their children, however, the professional who accompanies parents and who helps in encouraging them needs to be prepared. Communication and shift changes need to be trained. The objective of this work was to offer a workshop for students of speech therapy with experiences representing parents of children with hearing loss. Methodology: We randomly selected 10 Little Ears lessons as a template, delivered to students, duly matched to the sessions. Students split into a group of 3, each of which would represent the position of therapist, parent, child, and perform. As a result, the students attributed this activity as a way of experiencing possible situations with the child that may be unforeseen in the therapeutic set and learn to lead and empower parents and enhance the importance of dialogue and shift in activities in everyday life. They concluded that the activity made possible the most effective planning capacity focused on the empowerment of parents, on the power of words as a source of interlocution model, once the children activities assist in the development of auditory and language skills.

Targeted therapy – will it lead for hearing changes in children with cystic fibrosis?

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Introduction: 0–44% of children with cystic fibrosis (CF) suffer from various forms of hearing loss (HL). Features of the pathogenesis of CF, the use of massive aminoglycoside (AG) therapy can lead to hearing loss HL. A mutation in the CFTR (Cystic Fibrosis Transmembrane conductance Regulator) gene is the reason of the development of CF. The latest achievement in the treatment of CF was the discovery of small molecules that restore the processes of synthesis and transport of sodium and chloride ions. The effectiveness of drugs that restore CFTR function is aimed at ensuring that an adequate amount of CFTR protein is delivered to the surface of the epithelial cell. Medicines whose action is aimed at restoring the function of the CFTR protein are called CFTR modulators. The results of foreign and Russian scientists demonstrate significant improvement in clinical status of patients with CF receiving targeted drugs: the general condition stabilizes, functional indicators improve, body weight increases, the frequency of lung exacerbations decreases, lung function is restored, the functions of the digestive tract organs and fertile functions are improved and restored. We were unable to find any studies on the effect of targeted therapy on hearing in CF patients. The first modulator for patients homozygous for F508del in the CFTR gene was the combination drug Orkambi. In Russian Federation (2020) the proportion of patients with the F508del/F508del genotype is 30%. **Aim:** To assess the frequency of hearing impairment in children with CF and to determine the impact of targeted therapy (CFTR modulators) on hearing. **Material and methods:** The audiological examination was carried out in 110 children with CF, divided into age groups: 3–6, 7–11, 12–18 years old (y.o.). The control group consisted of 110 age-matched healthy children (HC). **Results:** Hearing impairment was detected in 15 (13.6%) patients with CF. HL was found in 10 (9.1%) HC: conductive, sensorineural and mixed hearing loss in 7, 2 and 1 subjects, respectively. The odds of having hearing loss did not differ between patients with CF and HC (OR=1.5789; 95%CI=0.6762–1.6869; p=0.2911). In both groups, conductive hearing loss was more common among preschool-age children and was caused by dysfunction of the auditory tube and/or exudative otitis media due to hypertrophy of the nasopharyngeal tonsil and its inflammation. The odds of having hearing loss were higher in children with CF aged 3–6 y.o. than in older subjects (OR=3.7576; 95%CI=1.1855–11.9103; p=0.0245). The frequency of the F508del/F508del genotype was higher in the CF group with hearing loss. Pseudomonas aeruginosa colonization was documented more frequently in this group of patients. Inhalation therapy with tobramycin did not increase hearing loss prevalence. Conclusions. In children with CF, hearing impairment is not more common than in healthy children. CF preschool-age children are more susceptible to the dysfunction of the auditory tube. Conductive hearing loss in CF patients is caused by exudative otitis media, whereas mixed and sensorineural forms of hearing loss result from cochlear damage due to aminoglycoside use.

Aminoglycoside inhalation therapy does not affect the auditory function of patients with cystic fibrosis. The duration of the disease and the frequency of aminoglycoside parenteral courses are key predictors of sensorineural hearing loss development. Given the prospect of Orkambi restoring the lost function of the CFTR protein, it can be assumed that targeted therapy may lead to increased (restoration of) sensitivity of cochlear hair cells to aminoglycosides, i.e. ototoxic damage to the hearing organ will manifest. Comprehensive audiological examination of children with CF receiving targeted therapy is the next step in our work.

Task repetition influence on pupil response in normal hearing adults

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Pupillometry has been commonly explored as a potential clinical tool with speech intelligibility tasks to reveal the cognitive impacts of signal to noise ratio, types of background noise, and hearing status on the cognitive aspects of speech perception. Pupils are reportedly enlarged in response to increases in task demands or listening effort. The current study aims to find the task repetition influence on pupil response in adults with normal hearing and to provide further insights into the roles of pupillometry parameters related to a short-term memory recall task. Participants were required to attend two days of trials in which they performed 14 trials each day, including four practices. Seven sentence sets were presented auditorily to the listeners and then they tried to remember sentence-first words. The recall performance was recorded after each set of sentences; a significant serial position effect was seen in recall performance on the first day only (p<0.05). The baseline pupil size tended to increase (p<0.01); while the peak pupil dilation tended to decrease during the phase when participants were encoding words heard against a competing speech background (p<0.01), indicating incrementally increased memory ability relative to the loss in an effort to listen and process the auditory inputs. In addition, these trends were steeper for the second day than for the first day (p <0.01) and all the three variables significantly increased on the second day. Pupil response averaged over multiple trials sufficiently provides real-time monitoring of cognitive resource allocation during the encoding process prior to the auditory recall task.

Teaching and learning English as a foreign language in children with listening attention deficit

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Central auditory processing disorders (CAPD) are deficits in the neural processing of auditory information in the central auditory nervous system. Studies have shown that CAPD are estimated to affect about 2–7% of schoolchildren. One of the most common CAPD types is listening attention deficit. CAPD have often a negative impact on a child's development, learning abilities, and social communication functioning. Moreover, CAPD are extremely important in learning a language in general, as well as a foreign language/languages. Due to the inappropriate reception of speech sounds, difficulties in their reproduction and understanding, students may have difficulties in learning language, e.g. in earning and remembering vocabulary and pronouncing words correctly. Additionally, it may further result in incorrect or even lack of the communication effect/result. It is also worth underlying that a number of parents report difficulties in learning foreign language/languages in their children suffering from (listening) attention deficit. Next, there are only few studies discussing the issue of learning and teaching English as a second language of CAPD students, including the evaluation of their achievements and progress. To the best of our knowledge, there are no scientific papers discussing the topic of teaching and learning the foreign language in school-age children with listening attention deficit (CAPD). The main aims of the study are, first, to present the literature review in this field and secondly, propose own pilot teaching solutions to gain students' attention, help them to better understand the speech, and be aware of the correct repeating/pronunciation of the words, as well as some tools to measure children progress. The program of learning English as a foreign language in children with listening attention deficit might be a valuable module of the therapy with the Stimulator of the Polymodal Sensory Perception by Skarżyński (SPPS-S).

Teste listening in spatialized noise sentences- LISN-S in Brazilian Portuguese

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Objectives: Spatial processing involves the ability to understand speech in a noisy environment which is directly related to the listener's ability to use binaural clues to differentiate sound source location from noise location. The spatial processing can be assessed by the Listening in Spatialized Noise Sentences (LISN-S) test, a binaural interaction test, applied by computer software using headphones, which produces a three-dimensional virtual auditory environment to evaluate spatial processing in individuals with complaints related to Central Auditory Processing Disorder. The main purpose of this study was to develop the LISN-S test (software and database in Portuguese), including normality criteria for the age group of 6 to 11 years. In addition, the results obtained in normal children will be analyzed and compared with those who had a history of otitis media in childhood. **Design:** The research will be developed in four steps: (1) Develop a software to assess spatial processing and speech material for the Portuguese database to be inserted into the software; (2)

Determine the relative intelligibility of sentences to make adjustments to the recordings and obtain intelligibility equivalence between them; (3) Determine normality criteria for a age group of 6 to 11 years, and (4) Compare the results between children with and without a history of otitis media. **Results:** The research was approved by the Institution's Ethical Commitee, under No. 3,462,572. A software written in MATLAB was developed to allow the application of the equalization procedure. A graphical interface was produced with MATLAB App Designer and it allowed the examiner to start the equalization procedure and, for each sentence, to input the number of correct words repeated by the subject. The software used this information to adjust the sound pressure level of the coming sentence. In addition to the graphical interface, the software is also responsible for interfacing with the audio interface through the PLAYREC library. 188 phrases created by the researchers were recorded by a vocal actress in an anechoic chamber using an AKG C3000 microphone connected via an RME MADIface Pro audio interface to a laptop equipped with Audacity audio editing software. Two children's stories were selected and recorded by three vocal actresses using the same recording procedures. All audio files were edited to remove periods of silence and normalized in level. Children are being selected from a public school to develop steps 2 and 3. **Conclusions:** Research is ongoing and software and speech material are ready for application in the selected sample. It is hoped that the results obtained in this research may provide support for understanding the functioning of the central auditory nervous system structures involved in binaural interaction tasks, from the cochlear nucleus to the auditory cortex in Brazilian children. In addition, we hope to disclose the importance of studying spatial processing, especially in children with complaints related to hearing difficulties in noisy environments, to contribute for the diagnosis and help audiologists to plan a more fully and efficiently rehabilitation.

Teste listening in spatialized noise sentences (LISN-S) in Brazilian Portuguese: sentence equalization step

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Objectives: The LISN-S is a test to evaluate auditory spatial processing. Currently it is only available in the English language. Therefore, a study is being carried out to develop the LISN-S test in Brazilian Portuguese, including presentation software, audio database in Portuguese and normality criteria for a age group from 6 to 11 years old. The steps to develop a software to assess spatial processing and speech material for the Portuguese database, which was inserted into the software, were concluded. Moreover, sentence intelligibility equalization has also been completed and the entire process will be described below. **Design:** This is a cross-sectional study approved by the Institution's Ethical Commitee, under No. 3,462,572. The sample consisted of 35 adults (median of 22 years; 30 females and 5 males) and 24 children aged between (median of 9 years; 8 females and 16 males). Inclusion criteria included normal hearing and good performance at school. Initially, the audiological assessment was applied which consisted of pure tone audiometry, speech audiometry and immittance testing followed by school performance test, which included writing and reading assessment. The Sentence Intelligibility Test was applied through a computer coupled to a Sennheiser HD 280 PRO headset via an RME Madiface audio interface. Each volunteer was instructed to repeat the phrase heard after the beep and to ignore the competitive story. The number of correctly repeated words was registered into the software to obtain the speech recognition threshold. All tests were performed in a silent room of a public school. Target sentences and competing histories were presented simultaneously in blocks of 31 sentences with rest in between. For the first block there was an extra 2 training sentences presented with a fixed 7dB signal-to-noise ratio (SNR). The remaining sentences were presented in an adaptive fashion. At the end of each block the Speech Recognition Threshold (SRT) was estimated. **Results:** For each subject we discarded the training, calculated an average SRT, and used it to normalize each sentence's SNR. An ANOVA test on the subject's normalized SRT (nSRT) indicated that two subjects performed significantly different than the others and where, therefore, discarded. Then, for each sentence, we fitted a logit curve to the percent correct word by nSNR using least square regression. All sentences whose corrected coefficient of determination (R^2) was smaller than 0.5 were also discarded. For the remaining sentences we selected the 120 sentences whose nSNR needed to achieve 50% correct identification of words (a) and slope of the steepest portion of the curve (b) were closest, in an Linf norm, to its median value, which resulted in $|a| < 1.9$ dB and $0.28 < b < 0.78$. The selected sentences were adjusted in amplitude by -a for equal intelligibility. **Conclusions:** Research is ongoing and software and speech material are ready for application in the selected sample. It is hoped that the results obtained in this research may provide support for understanding the functioning of the central auditory nervous system structures involved in binaural interaction tasks, from the cochlear nucleus to the auditory cortex.

The Bonebridge BCI 602 active transcutaneous bone conduction implant in children: objective and subjective benefits

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Background: The Bonebridge hearing implant is an active transcutaneous bone conduction implant suitable for various types of hearing loss. It was first launched in 2012 as the BCI 601, with a newer internal part (BCI 602) released in 2019. With the new size and shape, the BCI 602 can be used in patients previously excluded due to insufficient anatomical conditions, especially in patients with congenital defects of the outer and middle ear. **Objectives:** The purpose of this study is to evaluate the objective and subjective benefits of

the new Bonebridge BCI 602 in children who have hearing impairment due to conductive or mixed hearing loss. Safety and effectiveness of the device was assessed. **Material and methods:** The study group included 22 children aged 8–18 years (mean age 14.7 years) who had either conductive or mixed hearing loss. All patients were implanted unilaterally with the new Bonebridge BCI 602 implant. Pure tone audiometry, speech recognition tests (in quiet and noise), and free-field audiometry were performed before and after implantation. Word recognition scores were evaluated using the Demenkoand Pruszewicz Polish Monosyllabic Word Test, and speech reception thresholds in noise were assessed using the Polish Sentence Matrix Test. The subjective assessment of benefits was carried outusing the APHAB (Abbreviated Profile of Hearing Aid Benefit) questionnaire. **Results:** after implantation of the Bonebridge BCI 602 all patients showed a statistically significant improvement in hearing and speech understanding. The mean word recognition score (WRS) changed from 12.1% before implantation to 87.3% after 6 months. Mean speech reception threshold (SRT) before implantation was +4.79 dB SNR and improved to –1.29 dB SNR after 6 months. All patients showed stable postoperative results. The APHAB questionnaire showed that difficulties in hearing decreased after implantation, with a statistically significant improvement in global score. Pre-operative scores (*M*=35.7) were significantly worse than post-operative scores at 6 months (*M*=25.7). **Conclusions:** the present study confirms that the Bonebridge BCI 602 is an innovative and effective solution, especially for patients with conductive and mixed hearing loss due to anatomical ear defects. The Bonebridge BCI 602 system provides valuable and stable audiological and surgical benefits. Subjective assessment also confirms the effectiveness of the BCI 602. The BCI 602 offers the same amplification as the BCI 601, but with a smaller size. The smaller dimensions make it an effective treatment option for a wider group of patients, especially children with congenital defects of the outer and middle ear.

The clinical effect of steroids in preservation of hearing in patients who underwent cochlear implantation

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Background: A prospective clinical study was conducted to investigate whether two different pharmacotherapy strategies of steroid administration impact hearing preservation in adult patients who underwent cochlear implantation with the three different cochlear implants (Oticon Medical Neuro cochlear implant system, Advanced Bionics HiRes Ultra 3D and Med-El cochlear system). **Methods:** 100 adult participants were included. Pure tone audiometry was performed before implantation, during processor activation (in one subgroup between activation and 12 month after activation as well) and 12 months after activation. There were three treatment groups: (1) intravenous steroid therapy (standard steroid therapy with dexamethasone administrated intravenously at the dose 0.1 mg/kg body mass twice a day); (2) combined oral and intravenous steroid therapy (extended steroid therapy with dexamethasone administrated intravenously at the dose 0.1 mg/kg b.m. twice a day and prednisone (orally) at the dose 1 mg/kg body mass/24 h), and (3) no steroid therapy (a control group). Hearing preservation was established by pure tone audiometry based on the pre-operative and post-operative average hearing thresholds according to the formula developed by the HEARRING Network. Non-parametric test were used in statistical analysis. **Results:** Deterioration of hearing thresholds was observed in all patients' groups. In the Advanced Bionics group, majority of the patients in the intravenous study group had hearing preserved partially (77.8%). The similar was observed in the combination of steroid therapy (partial hearing preservation was found in 61.5% of the participants). The opposite was true in the subgroup without steroid therapy, most controls (38.5%) had no measurable hearing 12 months after activation. Patients with combined oral and IV steroid therapy (prolonged steroid therapy) had better results when compared with patients with intravenous (IV) steroid therapy (standard steroid therapy) and the control group. In the Oticon group, twelve months after surgery the patients with and without steroid therapy had similar hearing thresholds. In the Med-El group, patients with combined oral and IV steroid therapy (prolonged steroid therapy) had better results when compared with patients with intravenous (IV) steroid therapy (standard steroid therapy) and the control group. **Conclusions:** The steroid regimen used in this study may be beneficial in preservation of residual hearing with the type of implantation, surgical skills and initial conditions of patients. Patients with steroid therapy gained higher scores in hearing preservation.

The cognitive development of hearing impaired children with hearing aids and cochlear implant

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Objectives: The interdisciplinary follow-up program of hearing impaired children at the Comprehensive Hearing Center, Würzburg University Hospitals includes regular evaluation of children's general and cognitive development. Intelligence is evaluated at the intervals of the 24th and 48th month after first fitting. In this study, we investigate: 1. Cross-sectional comparison of cognitive/intelligence abilities between children with cochlear implantation (CI) and with hearing aids (HA). 2. Longitudinal evaluation of verbal and nonverbal (performance) Intelligence in CI children and HA children. **Material and methods:** 20 CI children and 23 HA children were evaluated at both intervals, using the Wechsler Preschool and Primary Scale of Intelligence Third Version (WPPSI-III) and Wechsler Intelligence Scale for Children Fourth Version (WISC-IV) depending on children's chronological age. The tests calculate different indexes (Intelligence quotients, IQ)

for verbal comprehension, perceptual reasoning, working memory and processing speed. The two times' evaluation data were analyzed in the present study. Significant was set as $p<0.05$. **Results:** 1. Study population: Up to September 2019, there were 20 CI children and 23 HA children who had two time evaluations. The average chronological age (years) at the first and second test in years for CI Children was 5.61 (*SD*=1.48) and 8.26 (*SD*=1.80) and for HA Children was 5.45 (*SD*=1.85) and 7.63 (*SD*=1.89). The hearing age (years), effective usage of CI/HA, at first and second test: CI children were 2.22 (*SD*=1.53) and 4.86 (*SD*=1.58) and HA children were 1.28 (*SD*=1.15) and 3.51 (*SD*=1.19). There was no significant difference in children's age between two groups at both evaluation times. 2. Comparisons between CI and HA children at both intervals: At 24th months evaluation, there was no significant differences according to group means of (1) verbal IQ in CI children (mean=98.40, *SD*=13.79) and HA children (mean=100.45, *SD*=16.68), $t=-0.39$, $p=0.70$; and (2) nonverbal IQ in CI children (mean=102.42, *SD*=16.11) and HA (mean=105.68, *SD*=16.89), $t=-0.61$, $p=0.55$. The same outcome was observed at 48 months evaluation: (1) verbal IQ in CI children (mean=108.35, *SD*=23.00) and HA children (mean=110.18, *SD*=16.97), $t=-0.29$, $p=0.78$; (2) nonverbal IQ CI (mean=108.95; *SD*=15.08) and HA children (mean=105.87, *SD*=17.76), $t=0.61$, $p=0.55$. 3. Longitudinal evaluation of cognitive development: Using repeated measurement analysis, in CI children, there was a significant difference in verbal IQ and non-verbal IQ between first and second evaluation ($F(1,13)=23.13$, $p=0.00$). Both sub-IQ at the second time was better than at first evaluation. There was a significant interaction effect between test time and components of intelligence ($F=6.46$, $p=0.03$). This indicated an accelerated positive development of CI children in verbal performances. In HA children there was no significant difference between two tests neither in verbal IQ nor in nonverbal IQ ($F(1,17)=3.09$, $p=0.10$). Also, there was no significant difference between verbal and nonverbal IQ in both tests ($F(1,17)=0.00$, $p=0.97$). **Conclusions:** 1. Cross-sectional comparison between CI and HA children: There is no significant difference in verbal and nonverbal IQ between CI and HA children neither in 24th months nor in the 48th months after intervention. 2. CI children's longitudinal intelligence performances, especially ability in verbal comprehension, continue accelerated after intervention. But this trend did not show in HA children. 3. In early evaluation, CI children's verbal IQ was significantly worse than nonverbal IQ but the difference disappeared over time.

The development and validation of the Korean-version Digits-in-Noise (K-DIN) test

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Objectives: Digits-in-noise (DIN) tests have been developed globally and used as various languages. Regardless, the Korean version of the DIN (K-DIN) test has not reported yet for the hearing screening test with noise. The purpose of the present study was to determine whether the diagnostic efficacy of K-DIN test is equivalent to that of the Korean speech perception-in-noise (K-SPIN) test, which is representative tool for speech-in-noise test. **Material:** Twenty-seven subjects (15 normal-hearing listeners and 12 hearing-aid users) participated. **Methods:** The recorded Korean 0–9 digits were used to form quasirandom digit triplets. 50 target digit triplets were presented at the most comfortable levels to each subject while presenting speech-shaped background noise at four levels of SNRs (+5, −5, −10, −12.5 dB). Subjects listened both target and noise in both ears, unilaterally and bilaterally through a headphone. K-SPIN test also was conducted at same procedure to the K-DIN test. After calculating their correct responses by a percentage, the K-DIN and K-SPIN tests were compared by a Pearson-correlation test. **Results:** The K-DIN test and the K-SPIN test were performed 74 times for each monaural and bilateral listening conditions. The results showed a statistically significant correlation between two tests in all listening conditions (left: $r=0.788$, $p<0.001$; right: $r=0.814$, $p<0.001$; bilateral: $r=0.727$, $p<0.001$). In the time consuming, the K-DIN test and the K-SPIN tests were about 5 minutes and 30 minutes, respectively. Further, the subjects reported that the K-DIN test was much easier than the K-SPIN test in terms of task performance. **Conclusions:** The current findings support that the K-DIN test is significantly correlated with the K-SPIN test in hearing-in-noise test performance, which implying that the K-DIN test can be used as a simpler and time-efficient hearing-in-noise test in Korea.

The effect of different stimulation rates on the auditory brainstem response

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Introduction: The auditory brainstem response is an electrophysiological examination that records the electrical activity of the auditory system. This potential may be influenced by several factors, including polarity, filter, stimulus intensity and stimulation rate. Given the possibility of changes in the stimulation rate causing deformations in wave morphologies, including changes in latency and amplitude, studying the effect of the use of different stimulation rates becomes essential. **Objective:** To compare the responses of auditory brainstem response with click stimuli at different stimulation rates. **Material and methods:** The cross-sectional observational analytical study was conducted with 15 participants of both sexes and normal hearing thresholds. Auditory brainstem response potential was performed at four different stimulation rates (21.1, 26.7, 27.7 stimuli per second and at a rate determined from a mathematical calculation using the grid frequency recording in the time of examination). **Results:** The Wilcoxon test showed that the rate of 21.1 stimuli per second presented the highest amplitudes of waves I, III and V when compared to the other rates. The rate of 26.7 stimuli per second, when compared to the rate of 27.7, showed higher amplitude for wave V, but when compared to the adjusted

rates, it showed lower amplitude for wave III. Adjusted rates, when compared to the rate of 27.7 stimuli per second, showed higher amplitudes of waves III and V. **Conclusions:** The study demonstrated that increased stimulation rate interferes with wave latencies and amplitudes, with worsening morphology of the waves I, III and V in auditory brainstem response.

The effect of noise exposure on vestibular function

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Objectives: The similarity of the functional anatomy of cochlear and vestibular cells, and the co-arterial vascularization of the cochlea and vestibular end organs increase the likelihood of vestibular damage co-occurring with noise exposure. Therefore, noise can cause damage to both the auditory and vestibular systems. The aim of this study was to assess the impact of noise exposure on vestibular function in patients with noise-induced hearing loss. **Material and methods:** The study included 80 subjects (40 subjects with noise-induced hearing loss, i.e. NIHL, and 40 controls without exposure to noise), 25–60 years old. Pure-Tone Audiometry (PTA), Extended High-Frequency Audiometry (EHFA), Tympanometry, Acoustic Reflex Threshold (ART), Distortion Product Otoacoustic Emission (DPOAE) tests, and Cervical and Ocular Vestibular Evoked Myogenic Potentials (c-VEMP and o-VEMP) were measured. **Results:** c-VEMP: The c-VEMP thresholds were significantly higher (M=86.2 dB nHL; SD=0.6 dB) in the NIHL group than in the control group (M=81.5 dB nHL; SD=0.6 dB), p<0.01. N1–P1 amplitudes were significantly smaller (M=84.9 μV; SD=10.9 μV) in the NIHL group than in the control group (M=141.8 μV; SD=11.4 μV), p<0.01. o-VEMP: The o-VEMP thresholds were significantly higher (M=88.7 dB nHL; SD=3.7 dB) in the NIHL group than in the control group (M=84.1 dB nHL; SD=3.18 dB), p<0.01. N1–P1 amplitudes were significantly smaller (M=2.0 μV; SD=1.6 μV) in the NIHL group than in the control group (M=3.6 μV, SD=2.71 μV), p<0.05. P1 latencies were significantly longer (M=15.8 ms; SD=1.9 ms) in the NIHL group than in the control group (M=14.7 ms; SD=2.0 ms), p<0.05. **Conclusions:** Noise can cause deterioration not only in the auditory, but also in vestibular function. It is recommended that VEMPs are routinely measured in subjects with NIHL.

The effects of noise on long latency auditory evoked potentials with verbal and non-verbal stimuli at different signal to noise ratios

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Introduction: One of the functions attributed to the auditory efferent system is related to the processing of acoustic stimuli in noise backgrounds. However, clinical implications and the neurophysiological mechanisms of this system is not fully understood, especially on higher regions of the central nervous system. Most of the studies that investigated efferent activity in humans used the inhibition of the otoacoustic emissions, which assesses the caudal region of the system when stimulated with competing noise. A few researchers studied the effects of noise on long latency auditory evoked potentials (LLAEP), but the lack of studies and contradictory results points out to the need of investigating different protocols and parameters that could allow the study of top-down activity in humans. **Objective:** to analyze the effects of contralateral white noise stimulation on LLAEP responses of school-aged children by comparing different SNR and different stimuli (verbal and non-verbal). **Methods:** 78 normal hearing children (aged 8–13 years) were evaluated using tone burst stimuli and the SNR +10 and 0 (experiment 1). In experiment 2, forty-one children were assessed with verbal stimuli (/da/ and /ba/ syllables) in the SNR +10. **Results:** Contralateral noise delayed P1 and P300 peak latencies and reduced P300 amplitude recorded with tone burst at both +10 and 0 SNR, but no differences were found between them. With verbal stimuli, noise delayed P1, N1, P2, N2 and P300 latencies. **Conclusions:** Contralateral white noise stimulation at SNR +10 can induce noise effects on PEALL in school-aged children. Verbal stimuli showed greater noise effects then non-verbal.

The effects of preoperative audio-visual speech perception on cochlear implantation outcomes in patients with postlingual deafness

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Objectives: Patients with postlingual deafness usually depend on visual information for communication, and their lipreading ability could influence cochlear implantation (CI) outcomes. However, it is unclear whether preoperative visual dependency in post-lingual deafness does positively or negatively affect the auditory rehabilitation after CI. Herein, we investigeated the influence of preoperative audio-visual perception ability on CI outcomes. **Material:** In this retrospective case-comparison study, 118 patients with postlingual deafness who underwent unilateral CI were enrolled. **Methods:** Evaluation of speech perception was performed under both audio-visual (AV) and audio-only (AO) conditions before and after the implantation. **Results:** Before CI, the speech perception test was performed under hearing aid-aided conditions. After CI, the speech perception test was performed under the CI-only condition. Only patients with a 10% or less preoperative AO speech perception score were included. In our multivariable regression analysis, age, gender, residual hearing, operation side, education level, and hearing aid usage were correlated with neither postoperative AV (pAV) nor AO (pAO) speech perception. However, duration of deafness showed significant negative correlation with both pAO (R^2=0.07183, p<0.05) and pAV (R^2=0.07497, p<0.05) speech perception. Notably, the preoperative AV speech perception score was not correlated with pAO speech perception (R^2=0.001336, p>0.05), but was positively associated with pAV speech perception (R^2=0.0731, p<0.05). **Conclusions:** In

conclusion, preoperative dependency on audio-visual information may positively influence pAV speech perception, but not pAO in patients with postlingual deafness.

The evaluation of the auditory benefits and quality of life in patients of different age groups after cochlear implantation

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Objective: The aim of the study was to assess postoperative, subjective hearing benefits and quality of life in patients in different age groups after cochlear implantation in range age from 28 to 72 years old. **Material:** This study included 40 patients (22 men and 18 women) who were undergone a cochlear implantation in World Hearing Center, Institute of Physiology and Pathology of Hearing in Poland. Patients were separated in two age groups: the first patient's age group was 20-40 years old and the second group was 60-80. **Methods:** All patients were asked to fill in questionnaires: the Assessment of Quality of Life (AqoL-8d) and Abbreviated Profile of Hearing Aid Benefit (APHAB). **Results:** The results of APHAB questionnaire showed that the percentage of problem before cochlear implantation in scale Ease of Communication was 68% in group of patients in range of age 20–40 and 60% in elderly group. After implantation procedure, the percentage of problems in both groups decreased significantly. On the Background Noise scale, the percentage of problems before implantation was 78% in the first group and 72% in second group. After the implantation procedure in both groups the percentage of problems decreased to 43% in the younger group and 47% in the elderly group. On the Reverberation scale, the percentage of problems before implantation was 72% in the first group and 68% in the second group. After implantation procedure in both groups the percentage of problems decreased. On the Aversivenses of Sounds scale the percentage of problems before implantation was 17% in the younger group and 38% in elderly group. After implantation procedure in both groups the percentage of problems increased. The quality of life in both groups was similar and was equal 63% for younger group and 61% for elderly group and increased after implantation. **Conclusions:** The above results may indicate that age may be an important factor which impacts on effectiveness and subjective benefits after cochlear implantation. It needs to be highlighted that conception of general quality of life can be related with other factors such as family life, social status and other disorders not directly association with hearing problems. It is important to using questionnaires which measure general quality of life and also dedicated for group of patients with hearing problems. It is important to assess areas which are directly associated with hearing and changes after treatment of hearing for example after cochlear implantation.

The influence of stapedotomy on the quality of life of otosclerosis patients

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Objectives: To measure self-assessed quality of life (QOL) in adult patients with otosclerosis after stapedotomy in terms of three major factors: change in audiometric hearing threshold, subjective hearing benefit, and tinnitus severity. **Material:** The study included a group of 191 adult patients who underwent stapedotomy in World Hearing Centre between April and October 2017 due to otosclerosis. **Methods:** Pure-tone audiometry (at 125–8,000 Hz) was conducted in the preoperative period and at 6-month follow-up. The pure tone average (PTA4) for air conduction (AC) and bone conduction (BC) was determined at 500, 1,000, 2,000, and 4,000 Hz. All patients filled a questionnaire before surgery and 6 months afterwards. Subjective hearing was assessed with the Abbreviated Profile for Hearing Aid Benefit (APHAB); tinnitus severity was established using the Tinnitus Functional Index (TFI), and the QOL was measured by the Glasgow Benefit Inventory (GBI). **Results:** Statistical analysis showed that the average GBI total score (mean=33.7; *SD*=23.7) was statistically significantly higher than zero (t=19.7; p<0.001). Based on a regression model, all the three variables studied – audiometric hearing thresholds change, APHAB change, and TFI change – had a significant effect on QOL after stapedotomy. Interestingly, the highest beta value (b=0.040; p<0.001) was for TFI change, implying that TFI change had the greatest effect on QOL. **Conclusions:** Stapes surgery provided a significant improvement in QOL reported by majority otosclerosis patients. For patients suffering from hearing loss and tinnitus severity in the course of otosclerosis, postoperative reduction of both ailments had a beneficial effect on the quality of life.

The method of rehabilitation treatment of patients after cochlear implantation using telemedicine technologies

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Introduction: Rehabilitation treatment after cochlear implantation is carried out in several large centers with courses of 10 days. The time between courses ranges from several months to a year. Short courses cannot provide full rehabilitation for patients. This is not always true. In some cases, absent. **Objective:** To

optimize the treatment method after cochlear implant surgery by introducing into clinical practice a new method of remote medical and pedagogical support for patients between inpatient treatment at cochlear implant centers, taking into account the territorial features of the Russian Federation. **Objective:** To evaluate the effectiveness of remote rehabilitation support for patients in remote regions, taking into account the use of telemedicine technologies, distance education of parents and patients. **Material and methods:** The study involved 10 children with a diagnosis of grade 4 SNT (ages 3 to 6 years). The control group consisted of 10 children with a diagnosis of grade 4 SNT (aged 3 to 6 years) who did not use remote support. Cochlear implants were installed in all inpatients (Concerto, MED-EL, Austria). At the first remote stage, after the operation and before the first connection, remote monitoring was performed by an ENT surgeon, video lectures to prepare for the first connection of the speech processor, psychological and pedagogical counseling of parents. Later, in the hospital, the first connection of the speech processor was carried out (OPUS 2, MED-EL, Austria). At the second, remote stage, continuous medical and pedagogical rehabilitation was carried out for 6 months, including weekly corrections of the appointment of the rehabilitation program as a sound educator, developing classes in the information system with an assessment of auditory developmental dynamics – 3 times a week, questioning parents, viewing educational lectures, distance learning sessions with Speech therapist and sign teacher. **Results:** A survey was conducted. 3 groups of questions were used: Evaluated the quality of the Internet connection, satisfaction with remote support, improving the quality of life. Overall satisfaction in the first patients was 74.5%. In the process of further optimization of the information system, patient satisfaction increased to 92%. All patients showed an improvement in quality of life. **Conclusions:** In the modern world, information technology is significantly developed. But in the field of cochlear implantation are not fully used. In the first months after connecting the speech processor, the child is most in need of intensive pedagogical rehabilitation. The method of remote support for patients allows in the most important period – after connecting to provide long-term continuous remote pedagogical and medical support and monitor the implementation of the rehabilitation program.

The pre- and postoperative assessment of frequency and severity tinnitus distress among adult patients qualified for cochlear implantation

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Objectives: Tinnitus is a symptom of high prevalence in patients with severe to profound sensorineural hearing loss. That hearing impairment can be treated with electrical stimulation via a Cochlear Implant (CI). The purpose of study was assessment the effect of cochlear implantation on pre- and postoperative tinnitus perception, which was evaluated, before, 1, 5 and 14 month after activation. **Material:** The study included patients undergoing cochlear implantation between August 2016 and January 2018 at the Institute of Physiology and Pathology of Hearing (Kajetany, Poland), who completed a battery of tinnitus questionnaires. The material constituted of 159 adults with severe-profound sensorineural hearing loss. All of them were first-time scheduled for cochlear implantation. **Methods:** All patients were asked to complete three tinnitus questionnaires in the following time intervals: before implantation (1st), one month after activation (2nd) and five month after activation (3rd) and 14 month after activation (4th). We used two questionnaires standardized and adapted into Polish language in our Institute: The Tinnitus and Hearing Survey (THS-POL, data unpublished yet) and the Tinnitus Handicap Inventory (THI-POL). The third questionnaire – Tinnitus Functional Index (TFI), was used in our study under Oregon Health and Science license obtained from authors of the original tool. **Results:** Before implantation, a problem with hearing ability was the main concern of the study group. There was one patient who rated tinnitus and hearing impairment as equal problems. Preoperatively, the mean THI score of the tinnitus patients was 46.4 (*SD*=21.7), and almost half the patients were classified as being more than moderately handicapped. After the operation, tinnitus somewhat decreased in 45.6% of patients. As a group, one month after CI the score was 25.6 (*SD*=21.9), classified as a mild severity. We observed a statistically significant change between the preoperative and CI activation periods ($t(45)=2.490$; $p=0.02$), as well as at 1 month follow-up ($t(45)=5.428$; $p<0.001$). Before implantation the biggest problem for patients with tinnitus was its intrusiveness (for around 60% of them). Moreover, tinnitus significantly impaired quality of life and hearing. One month after CI activation, the score for all domains decreased. **Conclusions:** To sum up, our results shows that prevalence of tinnitus in CI patients is relatively high. Although an increase in tinnitus questionnaires score can be observed in CI patients at activation, this change is not statistically significant. Furthermore, even after 1 month of CI use, the patients report significantly lower tinnitus distress in comparison to the preoperative period.

The prevalence of the hearing organ pathology among pupils of elementary school in two regions of Russia

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Introduction: The Ear, Throat and Nose Pathology and hearing loss is a major problem in children case, as it can be the cause of mental and speech underdevelopment A child with hearing loss has difficulties adapting to society and at school Plus breathing and nasal disorder causes hypoxia, which leads to increasing problems in education Every age group has different hearing impairment With newborns and toddlers it is mainly sensorineural Pre-school and school age is characterized by a wider list of factors leading to hearing loss Acute and chronic diseases of ENT organs, especially during the cold seasons in Russia, can also cause hearing loss. **Objective:** To determine the prevalence of ENT organ pathology and hearing impairment among primary school-age children in the autumn-spring seasons in two regions of Russia: Ufa and Novosibirsk. **Methods:** We evaluated 429 primary school-age children in Ufa and 216 from Novosibirsk A total of 645 schoolchildren (1 290 ears) were examined All

of them were between 7 to 11 years old Classical examination ENT organs with otoscopy, tonal threshold audiometry, tympanometry, TE OAE was performed. **Results:** In 849 ears (65.8%) the middle ear pathology was not detected and the otoscopy, tympanometry, tonal threshold audiometry corresponded to a healthy ear The TE OAE was registered Still the TE OAE was not registed in 441 ears (34.2%) In these cases different abnormalities were found Otoscopic results in this group of children were: inflow eardrum (64 ears), immobility or stiffness of the eardrum (286 ears), exudate in the tympanic cavity (72 ears), 'air bubbles' (19 ears), adhesion or petrification of the tympanic membrane (23 ears) and persistent perforation (19 ears) The degree of hearing loss was assessed in accordance with the International classification: weak degree (26–40 dB), moderate (41–55 dB), moderate severity (56–70 dB, severe (71–90 dB) and deafness (more than 90 dB) The results of the tonal threshold audiometry found a unilateral hearing impairment in 67 children, binaural – in 35 schoolchildren Often (264 ears) we observed an increase in the hearing threshold at one or more frequencies from 10 to 30 dB Hearing loss 1st, 2nd or 3rd degrees was detected in 137 ears Sensoneural hearing loss (SHL) was detected in 19 ears, conductive (CHL) in 87 ears, mixed (MHL) in 31 ears Two children had unilateral deafness The most often problems were revealed during ENT examination: acute infectious rhinitis and sinusitis (67 children), allergic rhinitis (23 children), chronic tonsillitis (34 children), hypertrophy of the adenoids (36 children) and other abnormalities (pathology of the nasal septum, vasomotor rhinitis, chronic sinusitis) Tympanometry showed that in 26.0% of cases, dysfunction of auditory tubes was detected (tympanogram type C) In 11.2% of cases, we observed exudative otitis with tympanogram type B We found that in 65% of cases, auditory tube dysfunction and exudative otitis were combined with various problems of the nasal cavity and nasopharynx. **Conclusions:** The data of the examination of schoolchildren show that the most common cause of hearing loss of primary school pupils is the pathology of the middle ear with conductive hearing loss Therefore, tympanometry is the most useful test that allows you to identify problems of the middle ear at an early stage We want to underline what the use of tonal threshold audiometry and TE OAE in the school is difficult due to the noise of the premises and the need for a soundproof cabin It is very important that none of the children actively complained about hearing loss or ear problems As a result parents were also not aware of the children's ear problems Teachers, on the other hand, often noted.

The quality of life of families with a small deaf child using a cochlear implant

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Objectives: The quality of life of a family is inevitably affected by the presence of a disabled child, for example, a deaf child. From the moment a child is diagnosed with deafness and/or other disability, its entire family finds itself in a new, often traumatic situation, facing numerous changes in their life. In Poland, existing studies on the quality of life of families with a disabled child concern only the families of children with other disabilities than deafness. This study aims to assess the quality of life of families with a small deaf child using a cochlear implant (or two) in the perception of their hearing mothers, compared to families with children with other disabilities. **Material:** The study included 50 families with a deaf child aged between 6 and 47 months using one or two cochlear implants. **Methods:** The mothers completed the Family Quality of Life Survey 2006 (FQOLS-2006) (Brown et al. 2006). That tool allows evaluating the situation, resources and needs of families in several areas of life: the health of the family, financial well-being, family relationships, support from other people, support from disability-related services, influence of values, careers and preparing for careers, leisure and recreation, and community interactions. We compared these results with the results of studies on the quality of life of families with children with other types of disability: motor, intellectual, autism and multiple disabilities (Otapowicz, Sakowicz-Boboryko, Wyrzykowska-Koda 2016). **Results:** The mothers gave the highest assessment to the quality of life of a family of a deaf child in the areas of family relationships, the health of the family and support from disability-related services. The overall quality of life of a family with a small deaf child has turned out to be higher at the level of a statistical trend (p=0.06) compared to the quality of life of families with children with other types of disability from the reference group. Mothers of deaf children, compared to mothers of children with other disabilities, give higher assessment to the quality of life of their families in following areas: family relationships, health of the family, support from other people, leisure and recreation, and influence of values. No differences were found between the assessment of the quality of life of families in following areas: support from disability-related services, financial well-being, careers and preparing for careers, community interactions. However, it turned out that mothers of deaf children who have higher education assess the quality of life of their family as higher in following areas: support from other people, careers and preparing for careers, and community interactions. **Conclusions:** The results obtained in the present study indicate that families with a small deaf child have a lowered quality of life. The highest assessment is given to family relationships, demonstrating their importance. It can be said that there are areas of life of families with a disabled child, related to their functioning in the society such as social interactions, support from others, or financial wellbeing, that still require changes in order to fulfill the needs and ensure better conditions of life of these families. Moreover, it should be noted that the present study involved families with a small deaf child, which has an impact on their characteristics seen presumably also in the obtained quality of life assessments. It is necessary to conduct longitudinal studies on the quality of life of families of deaf children, as well as qualitative studies that would allow defining the needs of families with a small deaf child in order to meet them.

The role of neurotransmitters in patients with tinnitus

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The aim of the conducted research is to assess the level of relative ratios of the concentration of brain metabolites of gamma-aminobutyric acid (GABA) and glutamic acid (Glx) in patients with tinnitus and control people by using the method of proton magnetic resonance spectroscopy (1HMRS). The study was conducted for groups of people with unilateral tinnitus, people with bilateral tinnitus and a control group without tinnitus. The control group was matched to patients in terms of hearing loss, age and sex. All people had normal hearing (people with hearing loss up to 35 dB at 8 kHz were allowed). The Magnetic Resonance Spectroscopy (1HMRS) method was used to determine the concentration of neurotransmitters in the brain. The spectra were obtained in the Single Voxel Spectroscopy, SVS technique. SVS voxels were set individually for each subject in the left and right frontal lobes and in the left and right temporal lobes. The result of the Magnetic Resonance Spectroscopy (1HMRS) test is presented in the form of a spectrum that was obtained by analyzing HMRS data in the LCModel program. Relative concentration ratios resulting from the concentration of the GABA or Glx metabolite to the concentration of creatine (the most stable neurotransmitter) were included into further analysis. Relative concentration ratios were compared within each person between the right and left hemispheres for the frontal and temporal region. Already in the first respondents, differences between the right and left hemispheres in relative ratios of glutamic acid and gamma-aminobutyric acid in the group of patients with unilateral tinnitus were noticed. The group of patients with bilateral tinnitus was compared with the control group in terms of the relative ratios of GABA and Glx metabolite to creatine. The relative level of the GABA metabolite was higher in the groups of patients with tinnitus in all assessed locations in the brain, which may indicate reduced inhibition in the temporal and frontal lobes in the case of tinnitus. Higher GABA concentration in the right than in the left frontal lobe in all groups may suggest different neuronal pathomechanisms in unilateral and bilateral tinnitus. The results obtained in this way will allow to verify the hypothesis regarding molecular pathomechanisms in tinnitus. They also allow the assessment of the role of neurotransmitters: gamma-aminobutyric acid and glutamic acid in the formation and maintenance of tinnitus in patients.

The Stimulation of Polymodal Sensory Perception by Skarżyński (SPPS-S): Comparison of stationary and remote therapy results

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Introduction: Hearing is a sense, which has a significant impact on a child's development. Disorders connected with hearing can have impact in a various forms and affect each area of life. Hearing disorders may concern peripheral auditory system as well as its parts responsible for central processing. It is estimated that central auditory processing disorders in its isolated form concern 2-3% of the population of school-age children, however, the problem co-occurring with other disorders may affect even several dozen per cents of children. According to the available recommendations, there are three main therapeutic approaches in the treatment of patients with auditory processing disorders: transforming the school environment, teaching the child strategies how to compensate his or her difficulties or using hearing trainings focused on a specific deficit. **Objective:** The main aim of the study is to present the results of SPPS-S therapy dedicated to patients with central auditory processing disorders who have completed the remote version of the method in comparison with patients performing therapy in a rehabilitation center. **Material and methods:** The Stimulation of Polymodal Sensory Perception by Skarżyński (original name in polish SPPS-S) is a treatment applicable for many different groups of disorders showing comorbidity with central auditory processing disorders. Solutions present in SPPS-S offer multifaceted therapy activating different perceptual modalities (hearing, vision and touch) at the same time, as well as their integration and coordination. Patient may receive the SPPS-S therapy either in the rehabilitation center or at home. The material used to assess the effectiveness of SPPS-S-based therapy included the results of 100 patients who received remote SPPS-S therapy compared to the results of 100 patients who performed therapy at a specialized center. **Results and conclusions:** Statistical analysis of the results obtained, which showed that the therapy used resulted in a statistically significant improvement in all auditory functions studied. Results confirm the high effectiveness of The Stimulation of Polymodal Sensory Perception by Skarżyński, both in stationary and remotely implemented form. The quality of telerehabilitation interventions was maintained at the same level as in therapeutic work at the therapeutic center, which was confirmed by the results of patients. Remote SPPS-S therapy as an effective telerahabilitation method has become an effective form of supporting patients in their own homes.

The use of electromyography in otolaryngological-phoniatric practice

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Introduction: The electrical activity of the inner muscles of the larynx was first recorded in 1944. Ten years later, phonation was correlated with phonation, which became the basis for the modern methodology of laryngeal electromyography (LEMG). Since the 1980s, EMG has been the diagnostic and prognostic standard for neuromuscular diseases used in neurological practice. It is only in the last few years that LEMG has become the subject of intensive work to adapt the examination to everyday clinical practice. This method, due to the unique nature of the muscles examined and the difficult anatomical accessibility, is within the mutual competence of the specialties of neurology and laryngology and phoniatrics. Over the years, LEMG has gained more and more new applications, ranging from diagnosis and prognosis of peripheral nerve damage, diagnosis of laryngeal systemic disease manifestations, phonation and singing, to monitoring of injection procedures. **Aim:** To present current guidelines for the analysis and interpretation of laryngeal electromyography, together with an overview of the mainstream use of EMG in otolaryngological and phoniatric practice. **Results:** According to current recommendations, it is advocated that LEMG be adapted and incorporated into standard clinical practice in otolaryngology departments. The analysis of EMG recording in interpretative standards includes qualitative assessment of the recording. The analysis of the literature shows that there are 4 main directions of using LEMG in otolaryngological-phoniatric practice: vocal fold disorders; research on laryngeal muscle physiology; intraoperative monitoring of laryngeal nerves; monitoring of laryngeal muscle function by superficial EMG (SEMG) in cases of dysphonia or dysphagia. **Conclusions:** The scientific community emphasises the importance of LEMG as part of otolaryngological and phoniatric diagnostic standards and is actively working towards its wider use. Current guidelines of American and European scientific societies from 2002 and 2009 encourage continuous development of the method. The perspectives of further development assume searching for appropriate objectifying parameters and changes in LEMG guidelines referring only to the qualitative description of the examination.

The utility of clinical tests and mobile posturography in the rehabilitation assessment in patients with balance disorders

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Objective: Size and type of postural disorders can be objectively determined in posturography, which is helpful in planning and monitoring rehabilitation effectiveness in patients with balance dysfunction. Mobile posturography registers stance and gait during patients'daily-life activities. Innovative mobile device – MediPost system consists of body-worn sensors including triaxial gyroscope and accelerometer. The aim of the study was to assess the postural control with use of clinical tests and MediPost device in patients with balance disorders after vestibular rehabilitation. **Material and methods:** Forty patients (mean age $\overline{x}$=56.8 yrs) with balance dysfunction, diagnosed and treated in The Norbert Barlicki Memorial Teaching Hospital in Lodz, were enrolled into the study. All patients filled the self-assessment survey about dizziness, Dizziness Handicap Inventory (DHI) and the short form of Vertigo Syndrome Scale (VSS-sf). They were examined clinically by the Tinetti Balance and Gait Test, Timed „Up and Go" test (TUG), the Berg Balance Scale (BBS), Dynamic Gait Index (DGI), the functional reach test (FR) and MediPost mobile posturography. Patients were assessed twice – before and one month after rehabilitation. They performed individually designed vestibular rehabilitation programme dedicated to patients' deficit, supervised by physiotherapist. Patients had for two weeks five-days exercises sessions, once daily for 60 minutes. **Results:** After rehabilitation, it was found significant reduction of dizziness intensity in Dizziness Handicap Inventory from severe to moderate handicap (55.9 vs 36.3 points, p<0.001), as well as in VSS-sf (19.7 vs 11.9 points, p<0.001). It was demonstrated statistically significant differences in all clinical tests, (before and after rehabilitation respectively: Tinnetti – 23.7 vs 26 points; TUG – 12.4 vs 8.5 points; BBS – 49.9 vs 52.5 points; DGI – 18.7 vs 21 points; for all comparisons p<0.001 and FR 29 vs 33 cm, p<0.01). The analysed parameters of MediPost were: center of pressure surface (mm^2), trajectory length (mm) and mean and max angular velocity (°/s). Results of mobile posturography pointed out improvement of the postural stability in almost all variants of examination, the best ones were mean and max angular velocity on the foam surface with closed eyes (7.0 vs 5.4 and 2.3 vs 1.9°/s, respectively). **Conclusions:** Clinical tests and posturographic registration with use of mobile MEDIPOST system provide objective assessment of postural control which is important in monitoring effectivness of vestibular rehabilitation in balance disorders.

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Tinnitus in the patient with neuroendocrine adenoma of middle ear (NAME) – case study

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Introduction: Neuroendocrine adenomas are tumors with double differentiation. Middle ear location of those tumors is rare. NAME causes various clinical signs. One of them could be tinnitus. **Material and methods:** A 23-years old patient was admitted to World Hearing Center due to right-sided hearing loss and tinnitus. Physical examination suggested tumor

of the middle ear. Patient underwent surgical treatment (atticoantromastoidectomy) with pathologic tissues excision and myringoplasty. For tinnitus evaluation, several questionaries' were applied (TFI, THI, THS). **Result:** Postoperative period was uneventful. Patient reported hearing improvement and tinnitus reduction. Histological examination revealed neuroendocrine adenoma of the middle ear.

Tinnitus severity change after stapes surgery

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Objectives: From a clinical point of view, it is important to measure how many patients suffer tinnitus before the operation, as well as its severity, and then, postoperatively, assess how well stapes surgery affected the tinnitus level. The aim of the current study was to determine how stapes surgery affects tinnitus severity. In addition, the relationship between reduction in tinnitus severity and hearing improvement after stapes surgery was analyzed. **Material:** This study included patients who qualified between April and October 2017 for surgical treatment of otosclerosis at a tertiary referral center. The main eligibility criteria were: age more than or equal to 18 years; preoperative audiological diagnosis indicative of otosclerosis; preoperative diagnosis of chronic tinnitus; no previous stapes surgery in the ear eligible for surgery; and no contraindication for taking part in a questionnaire study. Finally, a group of 168 otosclerosis adult patients diagnosed with chronic tinnitus were enrolled to the study. **Methods:** At the preoperative period and after 6 month's follow-up, pure-tone audiometry was conducted. The mean hearing thresholds for air conduction and bone conduction were determined at 500, 1000, 2000, and 4000 Hz. Tinnitus was diagnosed as clinically significant if it occurred at least once a week and lasted at least 5 minutes. Patients who were diagnosed with tinnitus were asked to fill in the Tinnitus Functional Index (TFI): 1 day before surgery (during the preoperative visit to the clinic) and after 3 and 6 months postoperatively. Stapedotomy procedure was performed in all cases. **Results:** The TFI Total score before the operation was M=34.5 (standard deviation, SD=1.6) points, and decreased 3 months after stapedotomy to M=17.5 (SD=1.7), a statistically significant change (T=–8.200; p<0.001). A weak correlation was found between the pre- and postoperative difference of TFI Total score and air-conduction thresholds (r=0.21; p=0.013) as well as between the TFI Total score and the size of the air-bone gap (r=0.21; p=0.013). Preoperatively, 86 patients tinnitus was a not or small problem, and for 82 it was moderate to very big. After stapedotomy, 93 (55%) of patients experienced a significant reduction in tinnitus severity. Of the whole group, 62 patients (37%) reported complete disappearance of their tinnitus. No change in tinnitus severity was reported by 63 patients (38%), and an increase was observed by 12 patients (7%). **Conclusions:** Stapedotomy not only improves hearing but also reduces tinnitus severity. The current results extend knowledge of postoperative results in terms of tinnitus severity, and might benefit patients undergoing tinnitus counseling. It might also be useful to otolaryngologists when making decisions regarding qualification criteria.

Tinnitus treatment: audiological characteristics before hearing aids use

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Objective: To evaluate the audiological characteristics of patients with tinnitus and to identify if there are differences between the group that perceived reduction in tinnitus after 2 months of hearing aids use and another group that did not obtain the same benefit. The hypothesis to be tested would be to know audiological characteristics that could previously indicate whether or not patients would benefit from reducing tinnitus only with the use of hearing aids. **Material and methods:** Twenty-nine subjects (28 to 68 years old) with hearing loss and complaint of tinnitus who were candidates for hearing aid use participated in this study. The groups were formed 2 months after the patients started using the hearing aids: Group I (GI) was composed of 20 participants (mean, 55.5 years old) who showed improvement in tinnitus perception after 2 months of hearing aid use; Group II (GII) was composed of nine participants (mean, 55 years) without improvement in tinnitus perception. The VAS (Visual Analog Scale) result after 2 months of hearing aid uses to determine the patients who would be assigned to GI and GII. Subjects who had a decrease in VAS formed the GI and patients with VAS equal to or increased after hearing aid use formed the GII. Procedures: The following battery of tests were performed before and after two months of hearing aid use: Tinnitus Handicap Inventory (THI), Hearing Handicap Inventory Elderly Screening Version (HHIE-S); pure-tone audiometry, logoaudiometry (speech reception threshold-SRT and word recognition), loudness discomfort level (LDL) at frequencies of 0.5; 1; 2; 3; 4; and 6 kHz short increment sensitivity index (SISI), Distortion product otoacoustic emissions. Foram realizados também os seguintes temporal auditory processing tests: Gaps-in-Noise (GIN), Random Gap Detection (RGDT), Pitch and Duration Pattern Sequence (PPS and DPS respectively). The psychoacoustic characteristics of tinnitus were assessed using acuphenometry, including psychoacoustic analyses of frequency (pitch) and intensity (loudness) as well as of the minimum masking level (MML). The same hearing aids brand were used and bilaterally and fitted according to the hearing loss of the participants. **Results:** There was a significant decrease in the scores obtained in the THI, HHIE-S questionnaires for both GI and GII after hearing aids use. Regarding acuphenometry measures, there was significant difference between initial and final loudness and Minimum Masking Level (MML) in GI, and intergroup difference (between GI and GII) in the final MML and loudness. There was no significant difference between the groups in the pure-tone

audiometry, speech tests, SISI, LDL, DPS and GIN. We found GI scores higher than GII in PPS test before hearing aids use, with a trend towards significance. **Conclusions:** The audiological characteristics evaluated were not sufficient to predict whether or not the patient with hearing loss would benefit from decreased tinnitus perception after two months of hearing aid use. Individuals with poor performance in PPS tend not to reduce the perception of tinnitus with the use of hearing aids. The present study points to the need to investigate other characteristics that may be associated with the difficulty of some individuals in reducing the perception of tinnitus with the use of hearing aids.

Treatment methods to improve hearing for patients with microtia and atresia- hearing devices options

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Microtia and atresia are congenital deformity; microtia refers to the spectrum of deformities of the external ear, atresia is the absence or closure of the external auditory canal. Defects occur in approximately 1 in 10,000 live births. Child with hearing loss should be provided with hearing devices as early as possible. In patients with microtia and atresia application of bone conduction hearing aids or implants is recommended. These devices transmit sound through the bones of the skull, bypassing the outer and middle ear, directly to the inner ear. Currently access to non-invasive devices using bone conduction stimulation increased. The purpose of this work is to show different possibilities for hearing improvement for patients with microtia and atresia. Nowaday there are available many types of bone conduction hearing aids with different way of anchorage. For young children hearing aids can be anchored in softband or adhesive adapter. For older children and adults hearing aids can be used in glass frame or stiff bands. Bone conduction hearing aids application in patients with microtia and atresia improves the sound localization ability and speech understanding in quiet and noise. Additionally in cases of conductive or mixed hearing loss the best method to improve hearing is to use bone conduction devices.

Triamcinolone acetonide as salvage treatment of idiopathic sudden sensorineural hearing loss: A retrospective study

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Objectives: Idiopathic sudden sensorineural hearing loss (ISSHL) is known as an abrupt and unilateral hearing loss (HL) of 30 dB or more in at least three consecutive frequencies within a period of 72 hours. Systemic treatment with steroids is widely accepted as first-line therapy. Intratympanic steroid injection represents an option for additional hearing improvement after failure of initial treatment. The most effective steroid for intratympanic treatment still remains unclear. This study aimed to retrospectively evaluate the efficacy of intratympanic triamcinolone-acetonide as salvage therapy of ISSHL. **Material:** A retrospective chart review was performed on patients affected by ISSHL without hearing recovery after primary systemic steroid treatment at the Department of Otorhinolaryngology, Medical University of Graz, from January 2014 to August 2019. Failure of primary treatment was defined as a persistent HL of 30 dB in pure tone average (PTA) after initial systemic steroid therapy. Patients received up to three injections with 40 mg/ml triamcinolone acetonide at one week intervals as salvage treatment. **Methods:** Hearing function was determined by pure tone audiograms. PTA was calculated by taking the average of the hearing threshold at 500 to 4000 Hz. The PTA of the contralateral healthy side was used to define the baseline hearing function. Severity of HL was defined as the difference between baseline PTA and initial PTA (PTA at first consultation after onset of hearing loss and before systemic treatment). Therapy outcome was assessed by change of PTA after the last steroid injection compared to initial PTA. Absolute hearing gain (initial PTA – PTA after steroid injections) and relative hearing gain ((absolute hearing gain) / (initial PTA – baseline PTA)) were calculated after the last ITS injection. Hearing recovery was classified as follows: Complete recovery was considered as a final PTA (dB HL) of maximum 10 dB greater than the contralateral side. Improvement of more than 10 db HL was defined as partial recovery. No recovery was determined as an improvement of less than 10 db HL. **Results:** For all subjects, the mean initial HL was 65±18.9 dB. Patients showed after primary treatment a mean HL of 62.3±19.1 dB. The mean absolute and relative hearing gain quantified 19±23.6 dB and 27.7±36.4%. Complete hearing recovery was noted in 15 patients (9.9%), while 73 patients (48%) obtained a partial recovery and 64 patients (42.1%) had no recovery. **Conclusions:** Triamcinolone acetonide represents a valuable candidate for intratympanic treatment as salvage therapy for idiopathic sudden sensorineural hearing loss. Further prospective clinical trials are necessary to evaluate this alternative therapy option.

Tympanoplasty after ear trauma: review of pathology, management and outcomes

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Objective: The aim of the retrospective study was to compare the reconstruction results of total (TORP) or partial (PORP) ossicular replacement prostheses after ear trauma. **Methods:** Fifteen patients with conductive or mixed hearing loss due to trauma were retrospectively analyzed. Patients underwent tympanoplasty in tertiary referral center between 2009 to 2018 using TORP (n=10 patients) or PORP (n=5). Their mean age was 36 years. 80% of the study group was men.

Demographic data, clinical data, audiometric data and intraoperative findings were collected. Air and bone conduction hearing thresholds were measured by pure tone audiometry on initial admission, at 1 and at least 2 years postoperatively. The hearing threshold was calculated as the mean value of the threshold for 500, 1000, 2000, and 4000 Hz. **Results:** The most common cause of ear injury was head trauma, then foreign body, burn and explosion. Incudostapedial disarticulation or damage of incus was the most common ossicular pathology. In the TORP group the air conduction pure tone average was 53.75±19.26 dB HL preoperatively, 42.38±21.04 dB HL 1 year postoperatively and 42.75±21.51 dB HL at least 2 years postoperatively. In the PORP group the air conduction pure tone average was 50.75±14.21 dB HL preoperatively, 37.50±17.39 dB HL 1 year postoperatively and 27.50±13.20 dB HL at least 2 years postoperatively. For TORP mean air-bone gap (ABG) was 35.00±10.70 dB before surgery, 1 year after surgery 25.63±13.01 dB and at least 2 years postoperatively 24.13±14.04 dB. In the PORP population mean air-bone gap (ABG) was 30.75±9.50 dB before surgery, 1 year after surgery 20.50±10.33 dB and at least 2 years postoperatively 12.50±5.52 dB. In the whole group 10 out of 15 cases (67%) showed a postoperative ABG of less than 20 dB. **Conclusions:** Ossicular disruption can be caused by multiple factors. Hearing results after immediate or delayed ossiculoplasty are apparently satisfying, although late cases are assumed to be associated with adhesion, cholesteatoma or fibrosis.

Use of synthesized higher order ambisonics impulse responses to generate virtual sound environments for hearing aids research

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Real-life situations are difficult to replicate in the laboratory and, thus, often discarded during Hearing Aids (HA) optimization, leading to performance inconsistencies and user dissatisfaction. The most prominent problems for HA users, such as the known cocktail party effect or accurate sound localization, are not entirely resolved. Current solutions using ray-tracing, image source methods (IMS) and Ambisonics still have to compromise between either realism or being adaptable to cover many different scenarios. This study proposes a new toolset that incorporates real-life conditions in the design, test and fitting of HAs with the aim to produce large datasets of accurate and diverse data to use in hearing aids research, which can then be used to train more complex machine learning (ML) algorithms. This toolset includes a spatial audio simulation framework for generating a large number of IRs corresponding to realistic situations using a mixture of IMS and Ambisonics, a machine learning (ML) algorithm focused on prominent HA problems trained with the abundant newly generated data, and a low-cost spatial audio solution for audiological clinics for improved fitting of HAs. The current article presents the first results of the spatial audio simulation framework compared to a reference scenario and other existent solutions in the literature. The simulation framework is capable of representing arbitrary number of sources with their corresponding directivities within the Ambisonics domain. The resulting IRs are later on used with any hearing aids device that are previously measured for HRIR characterization through a set of measurements without the necessity of an anechoic chamber thanks to post-processing techniques. The first findings demonstrate that synthesized higher-order Ambisonics (HOA) impulse responses (IR) can be a powerful tool for generating real-life situations for HA research. The reference situation generated with synthesized IRs demonstrated a match with the original measurement in terms of signal-to-noise ratio (SNR) and SNR gain in the case of a change in directivity settings of the HA device from omnidirectional to cardioid or adaptive beamforming. The devices are characterized by a fifty-point HRIR measurement in a diffuse field environment for testing purposes. In addition to SNR and SNR benefit, the interaural time differences seem to be kept intact compared to the original measurements validating the IRs and HRIRs as suitable to use in computer generated simulations rather than actual measurements for representing different scenarios. All the results demonstrate that the synthesized HOA IRs are a possible alternative to current solutions to generate a large set of realistic data to be deployed in ML algorithm training.

Usefulness of mobile posturography in diagnostics and rehabilitation in vertigo and balance disorders – a literature review

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Objective: Vertigo and dizziness are common complaints accounting about 15–35% of adult population. Postural stability may be assessed objectively by stance tasks in posturography, hovewer there is no consensus about most useful parameters (eg. Center of Pressure – COP, Center of Mass – COM). Recently, mobile posturography, based on body-wearable sensor technology, was developed and provides the possibility to measure COM during daily-life activities and in clinical tests for balance assessment and vestibular rehabilitation. **Aim:** The aim of the study was to review the literature about usefulness of mobile posturography in diagnostics and rehabilitation in vertigo and balance disorders. **Material and methods:** A search of electronic databases (Medline, PubMed and Embase) was done with key word; „mobile posturography". The following aspects of mobile devices were analysed: type, location and number of used sensors, methods of data analysis, protocols for clinical assessment (patient-reported outcome measures and clinical balance tests), mobile phone-based applications for fall detection, criteria for fallers/non-fallers and usefulness in balance disorders rehabilitation. **Results:** Different mobile devices, although prototype or commercially available (like VertiGuard® or SwayStar™) were used for diagnostics and rehabilitation. Mostly sensors are placed on the trunk, then on the foot and the leg. There is usually one or two sensors used in device, with application of accelerometers, gyroscopes and magnetometers based on microelectromechanical systems (MEMS). Mobile devices were used

in balance rehabilitation in many neurological diseases, mostly in patients with Parkinson's disease, multiple sclerosis, spinal cord injury, but also in vestibular and musculo-skeletal ones as well as in balance training and monitoring falls in healthy older patients. **Conclusions:** Mobile devices may be applied in diagnostics and rehabilitation of balance disorders as they are portable, small, inexpensive compared to classical posturography and give more valuable information in daily-living mobility. However more research is needed to provide standardized protocols and determine usefulness of mobile posturography in peripheral vestibular lesions.

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Using the automatic recording of auditory nerve responses in the rehabilitation of patients after cochlear implantation

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Objectives: Today, cochlear implantation is the only treatment for the fourth degree of hearing loss and deafness. The result of cochlear implantation depends on a careful selection of patients, a high-quality operation and the right rehabilitation tactics. An extremely important stage of the operation is intraoperative monitoring, which includes telemetry of the implant state, telemetry of the nervous response and registration of the electrically induced stapedial reflex. The first two stages are performed through special modules that are integrated into the software, the third stage is performed using a surgeon who visually determines the thresholds of the stapedial reflex. The aim of our work is to determine the relationship between the thresholds of the electrically induced stapedial reflex, the thresholds of the response of the auditory nerve, recorded in automatic mode and subjective levels of the most comfortable volume. **Material and methods:** We examined 25 patients aged 10 months to 42 years who underwent cochlear implantation using the Concerto cochlear implant (MedEl, Austria) at St. Petersburg Research Institute of ENT SPECIALIST. The threshold of the stapedial reflex and the threshold of response of the auditory nerve at 2, 5, 8, and 11 electrodes were recorded for each patient. It is worth noting that auditory nerve response thresholds were recorded in all patients, and the stapedial reflex was recorded only in 20. We also examined 30 late-deaf patients from 18 to 54 years old with experience of wearing a speech processor from 3 to 5 years, who performed cochlear implantation using the Concerto cochlear implant (MedEl, Austria) in St. Petersburg Research Institute of ENT. Each patient was configured with two training cards. The first map was created using subjective patient ratings, and the second using automatic recording of auditory nerve responses. Stimulation was performed on all electrodes. **Results and conclusions:** As our study showed, the thresholds of the stapedial reflex and the thresholds of response of the auditory nerve differ very slightly. On the 2nd electrode, the difference is 2%, on the 5th electrode – 5%, on the 8th electrode – 10%, on the 11th electrode – 7%. Maps created using different data were very similar in appearance to the tuning curve, however, they differed in volume. More often than not, maps created using automatic recording of auditory nerve responses were quieter than maps constructed from subjective assessments of patients. The best correlation between the maps was observed on electrodes 7 through 12.

Validity and reliability of the Hyperacusis Impact Questionnaire (HIQ) translated to Dutch

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Objectives: The most commonly used self-report questionnaire in Dutch for the assessment of hyperacusis is the Hyperacusis Questionnaire (HQ) developed by Khalfa et al (2002). However, the validity of this questionnaire, as well as its sensitivity to treatment effects has been questioned in past research. Therefore, a new Hyperacusis Impact Questionnaire (HIQ) was developed and validated in English by Aazh et al (2021) The objective of the current study was to translate the HIQ in Dutch, and to evaluate validity and reliability of the Dutch version of the HIQ. **Material and methods:** After a forward-back translation procedure to translate the HIQ to Dutch, the questionnaire was pretested to evaluate clarity and readability with six subjects with hyperacusis differing in age, gender and severity of hyperacusis. After clarifying some terms more in detail, the Dutch version of the HIQ was finalized. Together with the Dutch version of the HQ, the questionnaires were evaluated in 25 subjects (9 males, 16 females) with subjective complaints of hyperacusis with a mean age of 42.8 years (standard deviation (*SD*) 14.33, range 22–67 years), and a gender and age-matched group of 25 subjects without hyperacusis (mean age 42.8 years, *SD* 14.26, range 22–67 years). All subjects filled in both questionnaires twice with approximately two weeks interval. First, a factor analysis was conducted, and internal consistency was determined using Cronbach's alpha. Subsequently, test-retest reliability was evaluated using paired samples t-test and two-way mixed, single measures intraclass correlation coefficient. Third, based on the total scores, discriminability between the group with and without hyperacusis was determined using Mann-Whitney U test. Finally, convergent validity was evaluated using Spearman correlation coefficient between the total scores of the Dutch versions of the HIQ and HQ. **Results:** A single factor model with excellent Cronbach's alpha was determined for the Dutch version of HIQ. Second, no significant difference in total score of the Dutch version of the HIQ between test and retest was found, with an acceptable intraclass correlation coefficient. In addition, there was a significant difference in total score of the Dutch version of the HIQ between the group with and without hyperacusis, indicating good discriminability. Finally, a significant, strong correlation was found between the total scores of the Dutch versions of the HIQ and HQ, implying convergent validity.

Conclusions: The Dutch version of the HIQ is a valid and reliable tool for measuring the impact of hyperacusis. Future research is needed to evaluate the new translated questionnaire in a larger sample of subjects with subjective complaints of hyperacusis, varying in hyperacusis severity, and combining the results with measurements of hearing thresholds and uncomfortable loudness levels.

Vestibular schwannoma treatment and its relationship to tinnitus change

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Objectives: Schwannomas are a group of histologically benign tumors, which originate from Schwann cells, mainly in the vestibular part of VIII nerve. Literature data presents that vestibular schwannomas (VS) may be treated in three ways: observation and periodic control using MRI, radiotherapy and microsurgery. According to the guidelines of the National Institute of Health, one-stage microsurgical treatment is the recommended method due to its effectiveness. **Material:** Retrospective analysis of medical record of patients admitted to single tertiary clinical ENT center were carefully studied. The eligibility criteria were age ≥50 years, diagnosis of unilateral VS confirmed by a magnetic resonance imaging (MRI) and full medical record of a given patient upon diagnosis and follow-up (carried out within 12 months after operation), including medical interview and hearing evaluation. **Methods:** Patients were divided into three groups according to the treatment type: I group – patients under observation and periodic MRI monitoring, II group – patients undergoing radiotherapy, III group – patients undergoing microsurgery. **Results:** Based on eligibility criteria, 15 patients were included in the analysis. In the I group (observation), no statistically significant change in tumor size, tinnitus loudness and hearing thresholds was observed. Patients from the II group who underwent radiotherapy experienced statistically significant reduction of tumor size as well as tinnitus loudness. No change of hearing thresholds was observed in this group. Patients from the third group (microsurgery) experienced the biggest reduction in the tumor size and tinnitus loudness, however at the same time they experienced a significant deterioration of hearing. **Conclusions:** Microsurgical treatment seems to be the most effective in terms of tumor size reduction as well as tinnitus loudness reduction. However, it also leads to the significant hearing deterioration, resulting even in the complete loss of hearing in the operate ear. For this reason, it is necessary to thoroughly discuss the potential consequences of all of the therapies with the patient to let the patient choose the optimal decision in his or her individual case.

Vibrant Soundbridge in congenital external and middle ear deformation in patient with Goltz-Gorlin syndrome

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Introduction: The indications for Vibrant Soundbridge include sensorineural hearing loss with normal ossicles, mixed hearing loss in cases after radical modified operations with a presence of remnants of the ossicles, also in cases of chronic adhesive otitis media or even severe otosclerosis. Recently the middle ear implants have become the alternative in the treatment of hearing impairment in congenital deformations of external and middle ears in children. **Aim:** The objective of the study was to show the surgical technique used for VSB implantation in the patient with Goltz-Gorlin syndrome and analyze results obtained after surgical treatment. **Material and methods:** The child with Goltz-Gorlin syndrome was qualified to the VSB implantation. The patient presented with bilateral atresia of the external auditory canal and congenital deformation of the middle ears. Surgical technique included posterior atticotomy and facial nerve recess. We used the method of fixation of the FMT on the remnants of the ossicles without removing any of them. **Results and conclusions:** The benefits of Vibrant Soundbridge use are significant. We did not observe any surgical complications. Short and long-term hearing results in this case of congenital deformation of the external and middle ears are very encouraging.

Visual dependence after vestibular rehabilitation by virtual reality in individuals with peripheral vestibular hypofunction – one year of results

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Objective: The aim of the study is to compare visual dependence levels in individuals with peripheral vestibular hypofunction after vestibular rehabilitation program by virtual reality. **Material and methods:** For the evaluation of visual dependence, dynamic posturography was performed with the Balance Rehabilitation Unit equipment for 39 people with peripheral vestibular hypofunction before and after the vestibular rehabilitation program by virtual reality. Ten conditions were tested, with different visual and propriocetive stimuli. The parameters considered were the oscillation area of the pressure center and the sway velocity. **Results:** In the parameter of the oscillation area of the pressure center, statistically significant results were found in the 10 conditions tested. In the sway velocity parameter, statistically significant results were found in the condition 1, 2, 3, 4, 5 e 10. **Conclusions:** Virtual reality incorporated in the vestibular rehabilitation programs presents itself as an important tool in improving visual dependence in individuals with peripheral vestibular hypofunction.